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The Welding Engineer

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AUGUST, 1931 | VOL. 16, NO. 8

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Volume 16 | August, 1931 | Number 8

CONTENTS

How to Sell Welded Pipe Assemblies 25
By A. L. Byfield

Welding Interest Centers in Boston 27

Stress Relieving Welded Joints 29
By Robt. E. Kinkead

Welded Aluminum in Tank Trucks 35
By W. M. Dunlap

Resistance Welding Data 39
By Walter Anderson and Malcolm Clark

Structural Arc Welding Progress 42
By A. F. Davis

Hints for the Welder 47

Editorial 23

Arc Welded Steel Frame at Cost of Wood Framing 37
By C. M. Taylor

All Welded Tanks with Capacities up to 475,000 Gallons 40

Building a Job Welding Business 49
By W. Irving Brockson

How Fabricated Steel Cuts Costs 28

Bronze Weld Saves Long Shut Down in Gold Mine 34

Events and News of Interest 51

New Literature 53

New Products 54

News of the Industry 56

Another Way to Test Welds

HOW much of the welding done in your plant improves your product to the extent that you can advertise it as a *better* product because it is welded? Answering that question is a splendid qualitative test of the efficiency of your welding department. Some of the leading welding organizations in the country have already answered the question in their advertising. Others know that they could answer it satisfactorily. And still others are doubtful. More advertising of good welds would stimulate those in the doubtful class to take more interest in the control of weld quality and bring their welds into the first class. Recent advances made in the welding art are apt to result in more advertising of welded products, so that the public will expect the benefits of the best welding practice. In the future, then, a failed weld will reflect on its maker, rather than on the process used. If your welds will stand the advertising test now you should be letting the world know about it, because you cannot fail to profit from rapid public acceptance of the welded joint as being the ideal kind of joint in any metal product.

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The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

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Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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BUFFERS
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Metal & Thermit Corp.
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Weldit Acetylene Co.

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GASOLINE ENGINES
Continental Motors Corp.

GLOVES
Holcomb Safety Garment Co.
Ideal Face Shield Co.
Linde Air Products Co.

EDITORIAL

A Large Outlet for Steel

IN its issue of July 4th, the Cleveland *Plain-Dealer* carried a half-column story of the construction of a welded steel frame residence which was in process in Cleveland at that time, and concerning which some interesting details are given elsewhere in this issue. The newspaper report laid particular emphasis on the large number of people who visited the new type of house while it was in construction and upon the interest which steel men showed in the project. It is true that cost estimates indicated that the investment in the steel frame was a few dollars higher than that of a wood frame, but the difference is so small and the advantages of the steel frame so great, that the steel men were unanimous in their opinion that the steel frame house has been developed to a point where it offers a very important market for their product, the possibility actually being that residence construction may well account for a greater steel tonnage in the future than skyscraper construction. Their optimism is somewhat supported by later reports to the effect that before this house was completed, the architect began work on three more, all of them being built for regular clients. Steel frame residence construction has undoubtedly been held back by excessive cost and unsatisfactory design, but these handicaps are slowly giving way before the march of progress. Costs are being reduced through the media of more economical design and better acquaintance with erection and fabrication procedure. Similarly, the designs are becoming more flexible as the designers become better acquainted with the nature and the qualities of the welded joint. When the time comes in which architects are thoroughly acquainted with the welding processes and their possibilities, welded steel frame residences will not only be out of the experimental and luxury type of building, but will also represent a market for rolled steel which will undoubtedly realize the fondest dreams of the steel makers of today.

The Customer Will Pay for Quality

DURING a discussion of the new boiler code specifications for fusion welding at the spring meeting of the American Welding Society, there was some interesting discussion regarding the requirement for X-ray examination, from the point of view of the cost of such examination. The subject was handled by one of the speakers in such a way as to point out frankly that purchasers of welded articles, and particularly welded pressure vessels or power boilers, are willing to pay for this item of cost on account of its guarantee of quality. There may be some who are skeptical about such a statement simply because they have been experiencing the doubtful pleasure of selling in a buyer's market during the past two or three years. However there have been enough reports received during recent months of actual experiences to prove that the customer is not only willing, but anxious, to pay for quality, provided that quality has been sold to them. It is unreasonable to expect a cheerful payment for quality workmanship when the customer doesn't suspect that it is in the product. It must be remembered that an X-ray examination or any other non-destructive method of inspection is fundamentally just one item in the production program for the purpose of insuring quality in the finished product. There are at the present time several large manufacturers of welded products who have developed their procedures and who are selecting their materials with such care that they are able to produce welds of apparently startling quality. A number of these manufacturers have been using large space in industrial and engineering papers to advertise their ability to do this kind of welding. These manufacturers are contributing to the progress of the welding industry by teaching engineers some new lessons regarding the dependability of fusion welding. Hundreds of other manufacturers of welded products are overlooking an opportunity to capitalize this new impression which is being created. They are making welded products, but they are failing to let the public know that their products are being improved by welding. A great many advertising managers have an opportunity to make a new and stronger appeal to the public by showing that the welded product is a better product. Yet one seldom sees an advertisement directed to the general public in which this subject is mentioned.

His Biggest Order

THE proprietor of a very successful job welding shop was relating some of his experiences in building up a business. His first order from one customer came from a plant 50 miles away, and the amount charged on the order was only 75 cents. However, this job created a steady customer, and the welder proceeded to enumerate some of the subsequent jobs which had been received from the same source. One of the group who was listening to the story interrupted to ask for details about the biggest job ever handled for that particular customer. The welder immediately replied, "I have always considered that that 75-cent job was the biggest job on this account for the reason that it was the first job. It gave me an opportunity to show that the workmanship in my shop did not depend upon the size of the order, and the customer was so impressed by it that I am sure he has never lost his confidence in my shop. I think that I have continued to get all of his business since that first experience, without any exertion, simply because that first little job did all of the selling for the jobs which have followed." There is certainly something here for the job welder to think about every time he gets a new customer.

You'll Find It in Boston

GETTING back to normal business conditions involves more than merely a trend toward a greater volume of production. Too much production at too little profit has just been causing this country heaps of trouble. Normalcy should include dividends for stockholders on whatever volume of business is handled. In the welding industry the developments toward more profitable operation are rapid. Every year witnesses important contributions and 1931 is no exception. The welding minded man can help his firm take steps toward a better showing by getting posted on the offerings of this year, which he will find concentrated in the National Metal Congress and Exposition at Boston next month. In the meeting rooms, in the hotel lobbies and in and around the exhibits he will find the information he needs the most, whether it concerns theory, methods, machinery or materials. After all, this big metal event was established to serve as a national annual check-up on metal working practices. To miss it is to fall behind and be poorly prepared to meet the competition of better informed plants.

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New Rego CC Cutting Torch with 3 tips—choice of 90°, 75°, 35° or straight head assembly—choice of side or bottom lever.

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Get one. Order one today. It will change all your old ideas of cutting efficiency.

THE BASTIAN BLESSING COMPANY

246 E. Ontario St. Chicago

How to Sell Welded Pipe Assemblies*

A Working Knowledge of the Cardinal Points of Pipe Erection and Their Application by Welding Overcomes Sales Resistance

By A. L. Byfield†

ANY piping can approach perfection as nearly as it satisfies the main points required of a good job. These cardinal points of good piping are well worth knowing, because they they are points not quite observed by the architects and engineers themselves. In other words, the welding material salesman may have a little edge there. He will be the man who is listened to during the conversation if he brings out these points clearly.

We take them one by one. The first point is: Piping has to connect two objects in the shortest possible way which is consistent, of course, with other requirements.

The second point is that it shall contain as few mechanical joints as possible.

The third point is that the piping design shall inherently take care of expansion and contraction caused by the temperature differences.

The fourth point of the design is that the piping shall not take up more space than is absolutely necessary and shall by no means obstruct valuable space.

The fifth point of design is that the piping shall be flexible enough to take up vibration in itself, not transmitting it from one object to the other.

The sixth point is: The streamline flow which has to be followed in the design of the pipe. This is very often neglected in ordinary piping. The streamline flow is very important, especially at junctures where two bodies of liquids come together or where one body of liquid is divided in two and it is necessary to get the proper quantities, without friction, into the different branches, in different directions.

The seventh point is that the design of the piping shall be symmetrical in connecting similar objects, especially as to the location of valves, so as to minimize the possibility of an error on the part of the operator.

So far as piping materials are concerned, the piping should be homogeneous, that is of the same material all the way through if possible. This would avoid the difference in expansion coefficients between one part of the piping and the other; otherwise at the point where materials of different coefficients of expansion meet, there is bound to be a break of some kind or other in the pipe line. Again, the wall thickness of the pipe should not be weakened at any point. Then the pipe line should be as light as possible; that is to reduce the floor load and to reduce the weight of supports and hangers.

Furthermore, it must be of large enough size to keep the friction as low as possible, and lastly—it ought to be made up of as few parts as possible.

Welded piping consists of only four basic elements, if I include in those the valves which are necessary in any kind of piping. There will be three left if we take valves out. That is the pipe itself. Then for a change of direction, we have the Tube-Turn and where a connection is necessary for plant equipment or valves, a welding flange will be used.

From these three elements the entire piping can be put together in the simplest way. The wall thickness of the pipe lines at every point will be kept the same, whereas, in old-fashioned piping where flanges were attached by threads to the end of the pipe, the wall thickness was reduced by almost one-third. The architect or engineer carefully specified the wall thickness of the pipe, nevertheless he overlooked the fact that the piping cannot be stronger than its weakest point, which is at the threads.

From any good drawing of an installation made by welding it is possible to show how all the other requirements of good piping are carried out in a welded design. For that matter,

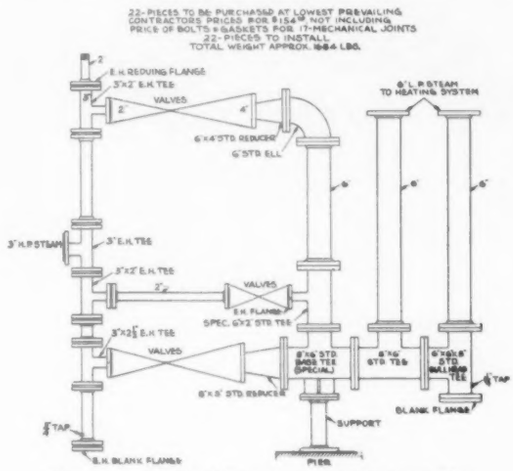


Figure 1. Typical Drawing of a Flanged Pipe Assembly.

it is best to take any of the architects drawings, or take any part of it and make a sketch for him, showing how that part will look welded. You can prove to him that the welded pipe line will be superior to the fitted line by virtue of the fact that the welded design:

1. Eliminates almost all of the mechanical joints;
2. Connects the objects in the shortest way by its freedom in using any angle in turning, angles which in fitted piping would require odd specials;
3. Takes up only as much space as is necessary to surround the liquid conveyed. In other words, it has no salient points like, for instance, a multiciplicity of flanges;
4. Enables any straight run of pipe between two turns to act as a medium for expansion because the weld at the turns cannot be loosened by the repeated movements of the straight runs;
5. Follows the stream of liquid by Tube-Turn sweeps welded in as nozzle;
6. Is often only half of the weight of the fixed piping;
7. Is composed only of three simple parts.

The result of an interview of this sort with the architect or engineer is that he at least consents to allow welding as an alternate, unless he is very old-fashioned and wouldn't change his fitted piping design until all the rest of his colleagues had changed theirs first. Usually he refers the whole matter to his contractors, if he has a job which is to be let, and asks the welding material salesman to go and try his hand on the contractors. If the contractors would follow the suggestion without raising the price, then he will consider the welding design.

This is result enough, because we know that welded piping

*Extract from a Paper Presented at the Mid-Winter Meeting, Gas Products Association, Chicago, January 28, 1931.

†Of Byfield, Ruzicka & Co., Chicago, Ill.

costs less than fitted piping. The contractor—if he has not welded before—would point out parts of the piping where it would be difficult to prove that welding is cheaper than a fitting but in his case you can take the entire layout and make a welding layout, figuring out for him a cut-and-dried price; how much that job will cost shop welded and shipped to the field in large welded units. If standard materials are used, flanged fittings are usually specified down to and inclusive 4 inch. If extra heavy materials are used, then the limit is around 2½ or 3 inches.

As a general rule we may say that we can replace any flanged job with a welded job at a lower cost. The contractor, of course, wouldn't believe this without proof. We

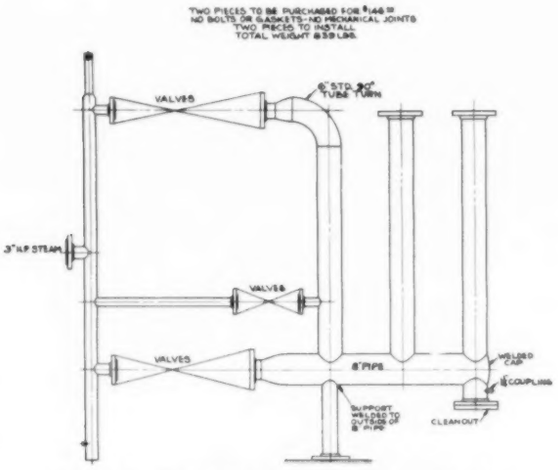


Figure 2. This Welded Assembly Replaces All Fittings Shown in Fig. 1.

have to make him a valid quotation on his job so he may compare it with his fitted cost. For instance Figure 1 shows a drawing which the contractor made. The architect in this case made just a lineal layout and told the contractor to put in all details. This is not unusual because many architects don't give the same exhaustive attention to piping problems as they do to the rest of their jobs.

The contractor laid out this pressure reducing plant. The high pressure steam is coming in on the three-inch line, and is reduced to low pressure by reducing valves at two places, at the 2½ and 2 in. nozzles. He has a 2-in. high pressure bypass between the high pressure header and the low pressure header. Then he heads the reduced pressure steam into two six-inch heating lines.

I won't criticize the design at all but will take it exactly as he has it. Now we can make a welded design, exactly the same as the fitted design. (See Figure 2.) He used twenty pieces for the fitted design and we show that we can replace these 20 pieces with two welded pieces. The cost of these two welded pieces, welded exactly to the fitted dimensions, costs less than the flanged fittings and flanged pipe alone, not counting the cost of the bolts and gaskets.

We leave it up to the contractor now to figure how much it would cost him to install the twenty pieces of the fitted design as compared with the two pieces of the welded design.

He sees at once that welded piping can be erected in half a day, whereas he figured that the fitted job would take nearly a week. Having given him a valid quotation for the two welded pieces we would then leave it to him whether he would order the main pieces welded as offered, or whether he would want to do the welding with his welders.

After the contractor is sold on welding there is very often an opportunity to simplify the design of his pipe lines, and show him additional savings, earning his appreciation and full confidence for future business. Here, for instance, we can make a design which is less costly than the first two were, lighter, and probably much better. (See Figure 3.)

Some time ago we installed a welding shop just for [illegible] purpose, so we could give the contractor a complete quotation and live up to that quotation. For instance, one contractor had a large job the other day for a large company. He bid the job fitted. We convinced him with our quotation that the whole job will cost much less welded, less in material and less in labor. He had confidence enough to go ahead with it. We prepared the welding drawings for him which he used. We usually prepare our drawings, by the way, in isometric form so he can give them to his foremen, in other words three-dimensional drawings where he can see the depth as well as the height and width at one glance.

We prepared such a drawing for him showing the entire job composed of a few large welded pieces. To his mind the whole matter amounted to this: instead of having many small and heavy pieces on the job he had about one-tenth the number of pieces, in large form and lighter than the cast fittings. Now, if he arranged his work so that his men were prepared to receive these few large fittings all at once he could get through with the installation in record time. He could never even think of such a quick installation if he had to use the smaller fittings.

The question has been raised as to the attitude of the boiler inspectors and insurance companies. Welding is allowed up to 15 pounds in boilers themselves. The boiler inspectors are not interested in piping which is separated from the boiler by valves. In other words, that is outside of the boiler itself. But they are interested in piping which is attached to the boiler nozzle and connects the boiler nozzle with the header up to the valves.

We had an interesting case with one boiler inspector. We furnished a welded expansion loop for a hospital. That expansion loop was to connect the boiler nozzle with the header

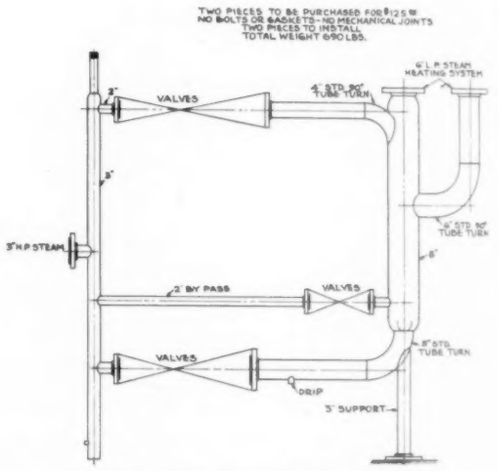


Figure 3. This Drawing Shows Further Simplification of Original Layout.

valve. The inspector, not knowing how the expansion loop was made, talked to the Superintendent of the Hospital, and scared the life out of him, saying that the expansion loop, on account of the repeated expansions and contractions would soon burst at the weld. He refused to insure the boiler. At that time we were about to weld up a similar expansion joint for the same hospital and invited the inspector to see how the welding was done, what procedure control we followed, and how the tests were made. He was thoroughly satisfied with the 900 pounds per square inch test pressure, and the hammer text, and passed favorably on this piping.

Insurance companies know that welding will be allowed for higher pressures in the near future, and it is their intention to gather as much information on welding as possible. They are glad to insure a job embodying good welding. The revision of the Boiler Code is also on the carpet now so that high pressure boilers may be welded up to a certain pressure.

Commonwealth Pier, Boston, Scene of the 1931 National Metal Exposition.

Welding Interest Centers in Boston

Six Technical Societies Will Meet to Discuss New Developments in Five Day Session

DURING the next month thousands of industrial corporations will be completing their plans for participation in the National Metal Congress and the National Metal Exposition, which will be held in Boston, Mass., September 21-25. Hundreds of these corporations will participate as exhibitors in the National Metal Exposition which will be held at Commonwealth Pier. Many others will be represented as contributors to the programs of about forty technical sessions of the six engineering organizations which are holding their conventions in Boston during that week. It is difficult to estimate the size of the group who will participate simply as visitors. Past experience, however, indicates that several thousand members of the participating societies will register at the various headquarters and that the exposition at Commonwealth Pier will serve between 50,000 and 60,000 visitors.

The management of the exposition has had years of experience in securing attendance of a worth-while group of individuals. Use will be made of newspaper advertising, direct mail advertising, radio programs, and distribution of complimentary tickets by exhibitors. All of these means of stimulating attendance are designed to attract the kind of visitors who would be interested in the equipment and materials displayed.

Due to the general decrease in activity in many industrial plants, it is expected that the higher executives and officials of many plants will be making plans to attend the Boston event this year, both because plant activities make smaller demands on their time and because they will realize the importance of getting first-hand information on the most up-to-date developments in the metal industries. They will be on the lookout for new materials which make it possible to improve their products and for new fabrication methods which may result in production economies in their plants when a trend toward a greater volume of production materializes. Those in charge of the management of the exposition have reported that each year they have received numerous comments on the size and character of the attendance and the interest displayed in the exhibits, and suggest that these are the reason back of the steady growth of the exposition. The first one, which was held in 1919, occupied only 10,000 square feet, but it now requires approximately 130,000 square feet to accommodate the many exhibitors.

It is well known that the general plan of the National Metal Congress and Exposition is to meet at a different place each year. The total program is a very comprehensive one, including the production, selection, fabrication, inspection, treatment and welding of metals of all kinds, both ferrous and non-ferrous. By selecting a different meeting place each year, the benefits are successively put at the disposal of hundreds of small plants or small firms who would not feel justified in sending representatives to conventions and expositions at distant points. New England is well-known as a very important territory for the purchase and production of metal products. There are millions of people located within automobile driving distance of Boston and millions more within a distance of an overnight ride by rail. The setting is therefore a favorable one from a business point of view, and the city itself has many attractions which make it a delightful place to visit. For those who are interested in welding subjects, the centers of interest will be the welding section of the National Metal Exposition on Commonwealth Pier, where practically all kinds of welding apparatus and materials will be displayed and demonstrated, many of the products being brand new developments which are shown here for the first time, and the technical sessions of the American Welding Society fall meeting which will be held at the Copley Plaza Hotel. The Meetings and Papers Committee has practically completed the program, and promise that it will be without exception one of the greatest meetings ever held by the Society.

The meeting will open formally on Monday, September 21st, with the meeting of the Structural Steel Welding Committee. A summary of a report of the results of a large series of tests made by this committee will be presented at this meeting, as will also a discussion of the additional investigations which are to be undertaken. It will be remembered that these tests were made for the purpose of determining whether or not a satisfactory degree of uniformity could be obtained by welding operators in widely scattered commercial welding shops, and enough information has already

been received to show that such uniformity is easily possible provided a uniform program of qualifying the operators is followed. Undoubtedly the publication of the complete report will furnish information which will be useful throughout the welding industry in addition to its specific use in solving some of the problems involved in the welding of structural steel.

During the succeeding four days of the meeting there will be six technical sessions, at which there will be presented some fourteen technical papers covering many important phases of welding and cutting. All processes of welding will be covered, including manual and automatic applications. There will be special papers on the welding of non-ferrous metals, corrosion resisting steels, welding of machinery parts, annealing, welded piping, welding in ship construction and structural steel welding.

Registration for the American Welding Society meeting will commence Monday morning, September 21st. Tuesday afternoon, September 22nd, there will be an inspection trip. The annual banquet and dinner will be held on Thursday evening, September 24th. The committee on arrangements has already announced that special efforts have been made to provide an attractive entertainment program for members and guests and for the ladies.

Boston will be the center of interest for the welding industry in September. The National Metal Congress and Exposition will have something definitely valuable to offer to all those who are interested in the welding processes from any point of view, whether they be operators, foremen, salesmen, plant managers, engineers, instructors, supervisors or manufacturers.

How Fabricated Steel Cuts Costs

Three jobs recently completed by the United District Heating, Inc., Cleveland, Ohio, and illustrated in the accompanying photographs, are excellent examples of the kind of savings which can be made in manufacturing with plate steel as the raw material and with welding and cutting equipment for the tools. Figure 1 shows a forming die for a bull-dozer

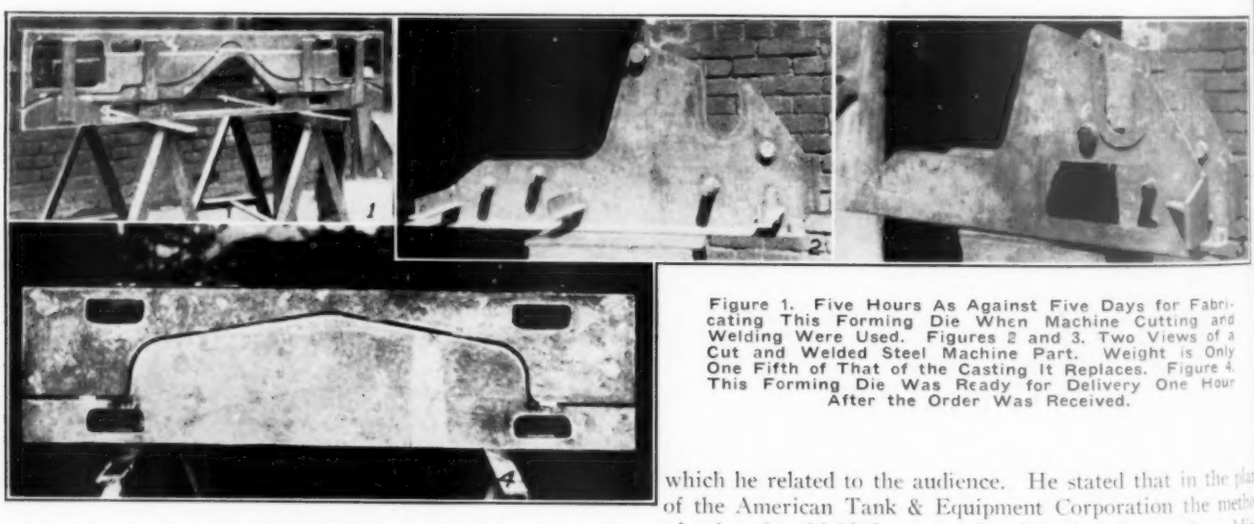


Figure 1. Five Hours As Against Five Days for Fabricating This Forming Die When Machine Cutting and Welding Were Used. Figures 2 and 3. Two Views of a Cut and Welded Steel Machine Part. Weight is Only One Fifth of That of the Casting It Replaces. Figure 4. This Forming Die Was Ready for Delivery One Hour After the Order Was Received.

which was cut to shape from 2-inch and 1-inch steel stock on the Oxygraph. The photograph shows clearly how the 1-inch pieces were welded on to the 2-inch stock. The flat strips which are welded on in a vertical position are guide bars. The customer had stated that by the old method of making these forming dies in their own shop five days were required, whereas by using the method illustrated, it only took five hours to get the same result.

Figures 2 and 3 show a machine part fabricated from steel plate and structural shapes, the steel plate being cut out with the Oxygraph and then fabricated by electric arc welding. This fabricated piece replaces a cast iron part, and is only about one-fifth the weight of the former cast iron piece. It happens in this case that the cost of producing both the cast iron and the fabricated steel parts are about the same. However, the reduction in weight was of great advantage, because this particular part is detachable from the machine of which it forms a member, and has to be removed at frequent intervals. Therefore, the cost of handling is greatly reduced by having the lighter member.

Figure 4 is another forming die, but of much simpler construction than that shown in Figure 1. It is of 2-inch steel stock cut from a template on the Oxygraph. This piece was ready to deliver to the customer in the form shown in the photograph within one hour after the order had been received in the shop. Such speed, of course, cannot be approached anywhere by any previous methods of making this type of forming dies.

Tells Engineers to Watch Welding Developments

In a recent talk entitled "A Revolution in Joints," presented to the Engineers Club of Oklahoma City, Okla., H. G. Raymond, Vice-President of the American Tank & Equipment Corporation, declared that within five years from today the evolution in the methods of fastening metal parts together will be complete. He predicted that improvements in the various arts of welding will be carried to the point where no joining methods will be tolerated which will develop less than 100% strength of the parts joined. He pointed to the outstanding accomplishments already made by welding engineers in the automobile industry, in the oil and gas pipe line field, in the construction of heavy machine frames, in ship construction, in building construction, and in tank and pressure vessel work. He then pointed out that welded construction has been made to meet the exacting requirements of the pressure vessels used in the oil industry through the development of the shielded arc method of welding, the history of which he related to the audience. He stated that in the plant of the American Tank & Equipment Corporation the method of using the shielded arc consists in using automatic welding heads feeding continuous reels of bare wire and supplying the reducing gaseous shield separately. He pointed out that in using this process, the joints to be welded must be carefully prepared in a planer because a small deviation in the contour makes a difference. He further stated that using this special process, the plant is producing welded work which has nearly 100% the strength of the parts joined and that prices are competitive with riveted work in which it is seldom possible to produce a joint strength of greater than 86%.

Stress Relieving Welded Joints

Discussion of Test Results Indicating That Industrial Plants Can Eliminate Costly Reheating Operations Through the Use of Proper Welding Procedure and Mechanical Methods of Stress Relief

By Robt. E. Kinkead†

(Concluded from July issue)

How Metal Behaves When It Cools

WELDING with oxy-acetylene torch or the electric arc involves heating the metal to the molten state. In any study of residual strain we are interested to know how the metal behaves when it cools. It is well known, for instance, that an allowance is usually made of ¼ in. shrinkage per foot in steel castings. The weld is a cast casting and we might expect it to shrink ¼ in. to the foot when applied to a welded structure. If it did shrink this amount in all probability there would be a negligible amount of residual strain in the weld when cold. But there are some very good reasons why a weld does not shrink this amount. In many cases the weld is made between two parts which cannot move with reference to each other. But in trying to shrink ¼ in. to a foot, the weld sets up what we call residual strain.

The conditions in a weld are so complex and subject to so many variables that it is difficult to produce any experimental data which has a general application to welding problems. But it is of value and interest to know the characteristic curve of strain set up in a shrinking piece of steel which is not free to move. With this thought in mind a set-up of apparatus was made as shown in Figure 15. A bar ¾ in. square was laid on two supports; being at the outset rigidly attached to one support, but free to move on the other. A Huggenberger tensometer was applied to the bar as shown. Pyrometer elements were applied at the point at which the heat was to be applied so that a record of the temperatures could be kept. Fire brick was applied around the bar so that a length of about 3 inches could be heated. After the 3-inch section was brought to a temperature of about 1,750 degrees Fahrenheit, the free end of the bar was welded to its support. (Due to conduction, about 3 additional inches of the bar was heated to over 1,000 degrees Fahrenheit.) From time to time, pyrometer readings with the corresponding tensometer readings were taken to record the stress in the bar at small decrements of temperature as the bar cooled. The curve in Figure 16 shows these readings in graphical form. Since the length of bar treated affected the stress set up in the remaining portion, a series of hypothetical curves have been drawn in to take care of the situation when a smaller percentage of the length of the bar was heated, as well as when a larger percentage of the length of the bar was heated.

We may assume that the weld behaves in a manner indicated by one of these curves. We cannot tell which particular curve without knowing the dimensions and other particular conditions surrounding the weld. This applies of course to only one welding bead. If more than one welding bead is applied, the conditions become far too complex to show graphically and have that curve applicable to some other set of conditions.

It appears evident from the curve that below a temperature of about 1,100 degrees Fahrenheit, the stresses produced by contraction are below the elastic limit of the parent metal. Above a temperature of 1,100 degrees Fahrenheit the contraction stresses are greater than the elastic limit of the material. At a temperature of about 1,400 degrees Fahrenheit the elastic limit of the material is zero. Above 1,400 degrees Fahrenheit the strength again increases, but decreases to zero at about 1,750 degrees Fahrenheit. It appears reasonable to assume that the recalescent point of the steel occurred somewhere close to 1,400 degrees Fahrenheit.

It seems fairly evident from the characteristic curve referred to above, that residual stress can only be relieved by applying some stress to the metal which is greater than the yield point of the metal at that temperature, so that the piece takes a permanent deformation, thereby relieving the restriction to movement which is the cause of the residual stress. In the case of the bar on which the readings were taken, it was at once evident that there are two ways in which residual stress due to cooling could have been removed.

The first method would involve heating the bar, as well as the rigid plate to which it was attached, to such a temperature as to permit the yield point of the bar to be exceeded by a sufficient amount to relieve the stresses set up by the experimental cycle in which the bar was heated and cooled, without heating the plate. At this high temperature there would be no residual stress and if the bar and the plate were cooled at a uniform rate there would be no residual stress in the bar when both were cool. This is the basic principle of stress relieving by the application of heat. The same result might have been obtained by stressing the bar cold to a point above the yield point. In this case, the bar would have simply elongated a sufficient amount to relieve the stresses set up by contraction. Also, in elongating, the cross section of the bar would necessarily have been reduced, thus relieving strains in a plane perpendicular to the long dimension.

What is the lime-wash test for residual strains? Why is it used? What information does it give? Can it be applied to all welds? Is steel injured by being stressed beyond the yield point? Does heating to 1100 degrees Fahrenheit relieve all of the locked up stresses around the weld?

You will find technical data on these subjects in this article, which is the second of a series of two articles on the subject of Stress Relieving, written by Mr. Kinkead. Stress relieving is a subject of great importance to all those who are doing welding on structures which require maximum strength. Discussion of these articles is invited.

DIAGRAM OF APPARATUS FOR MEASURING STRESS DUE TO COOLING OF ¾ SQUARE STEEL BAR.

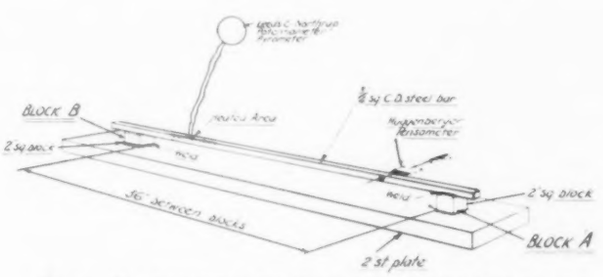


Figure 15. Apparatus for Measuring Cooling Strains in a Steel Bar.

†Welding Engineer, Cleveland, Ohio.

It is to be noted that if the bar were reheated without heating the plate to the same such temperature as 800 degrees Fahrenheit and allowed to cool, the stress set up by the first cycle would not be removed.

As has been stated before, in any general solution to the problem of stress relieving a weld, it must be assumed that the amount of residual stress present is unknown unless its amount can be proven. In particular cases, it might be known with a satisfying degree of precision, but in considering the matter in a general way we may assume that the exact amount of residual stress present in the weld is unknown.

Referring to Figure 17, two well-known types of welds have been illustrated. For the sake of argument we may assume that the residual stress is in the form of the couple A-B in either type of weld. This assumption is legitimate since we know that the metal in the weld tended to contract, but that it was prevented from contracting freely by the fact that it was fused to the original plate. Since action and reaction are equal and opposite in a system of forces in which a state of equilibrium exists we know that additional couples exist, such as A-C and B-D. The force C in all cases represents the preloading of the parent metal due to residual strain from the weld.

Referring to the previous discussion, the necessary condition to a relief of this residual stress is that the metal shall be stressed beyond the yield point. Since plasticity is the opposite of elasticity, the metal must be brought to the plastic state in order to accomplish stress relief. This may be accomplished by heat or tension or both.

It seems obvious that if preloading exists, due to residual stress in the weld, that the metal in which the preloading occurs will reach its yield point under a tension load before the metal will reach its elastic limit which is not subject to preloading. In other words, a method has been found which enables us to find, in a given case, what the actual preloading amounted to, due to residual stress in that particular welded joint. If no residual stress were present, no preloading was present, and the yield point of the parent metal in tension would be reached at some point in stress which would be determined by the contour of the bar tested and its basic physical properties and would be entirely independent of the weld.

In order to check this hypothesis two welded coupons, as shown in Figure 17 were put in the tension testing machine and the stresses measured by Huggenberger tensometers at points very close to the weld, (1¼ from CL) as indicated on the sketches. The plates from which these coupons were cut were butted tightly together preparatory to welding. However, in this case the plates were left free to move out of a horizontal plane due to stress in the weld. The principal stresses which we would expect to be set up by the cooling weld metal are shown in the sketch (Figure 17). It is evident that the stresses might be very high under certain conditions as the last layers of the welds were completed, since at this point movement of the plates out of a horizontal plane is inhibited by the weld itself. The curve in Figure 18 gives the data obtained from this test. It is apparent that stress concentration existed in the single groove weld due to deformation resulting from residual stress, but that none existed in the double groove weld. Since it was not safe to carry the test up to the elastic limit with the tensometers attached, another pair of coupons were cut from the same two welded plates and put in the tension testing machine. On this test the coupons were given a lime wash. Figure 19 shows the condition of the lime wash at the yield point as well as at several other points.

From the two tests it is apparent that the tensometers indicated what would happen when the lime wash was applied. The lime wash test gave the results expected. The use of lime wash for detecting the point at which the stress in boiler plate under tension reached the yield point has been used many times before, and this test further indicates its ... ability. The test shows clearly that no preloading due ... residual stress could be observed in the double groove ... This does not prove, in our opinion, that all two-side ... will be free from appreciable residual stress. But the ... clearly indicates that appreciable residual stress was not ... ent in the two-side weld coupons tested. The two-side ... was made by a method which is known to reduce resi... strains due to welding to a very low value. In this case ... strains set up by welding were less than could be measu...

Stress Relieving Pressure Vessels

From the foregoing discussions of the studies made on re... ual stresses in welded bars, it appears very reasonable to ... lieve that the fundamental facts are applicable to the st... relieving of welded pressure vessels. We have, in these tests ...

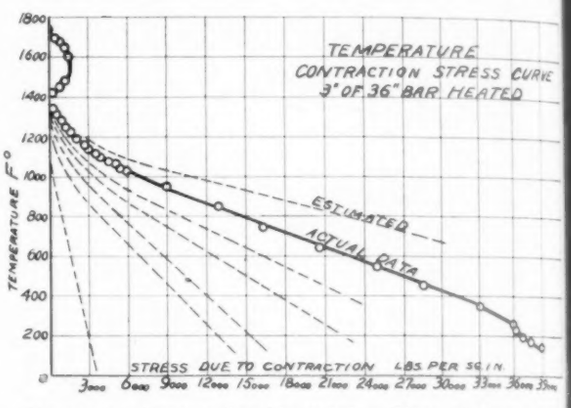


Figure 16. Stresses Set Up When a Piece of Steel Cools

plain indication of a method of finding out when resi... stresses are present and a method of relieving them. Thus, ... pressure vessel is given the lime wash and internal pres... applied to the point at which the elastic limit of the pl... is reached some place in the vessel, we can determine wi... fair degree of precision the amount of residual stress pre... in that particular vessel. If the lime scales off at some st... below the yield point of the plate, the amount below the y... point of the plate gives a measure of residual stress pr... ent. At the same time, defects due to failure of fusion, exc... sive porosity, undercutting—when present to a damaging ... gree—will be shown up. When scaling of the lime wash ... due to such causes, carrying the internal pressure to a hig... value will cause failure. This method could not be appli... of course, to a structure to which internal pressure ca... not be applied.

If the residual stresses are present and shown by the sc... ing of lime at some point far below the yield point of ... plate, these stresses may be completely relieved by carry... the stress in the plate slightly beyond that point. In do... this, we will have fulfilled the fundamental condition of ... ceeding the yield point and producing a permanent defor... tion. While it would probably not be commercially necess... to carry every vessel up to the yield point of the plate in ... longitudinal seams, the method permits an entirely reli... method of determining how much and where the resi... stresses are.

From the discussion above it seems apparent that defor... tion of the plate adjacent to the weld due to welding str... should not be permissible beyond the ordinary limits set ... inaccuracy of dimension. If the welding process produ... such deformation, it is evident that the whole procedure ... got out of control. Stress relieving by heat will not take ... the deformation, so that the stress concentration rem... and it may exceed the stress concentration due to resi... stresses in the weld.

In stress relieving a pressure vessel in the manner descri... above by the use of internal pressure we are accomplish... the same thing that is accomplished by putting the vessel ...

rnace and heating it up to the point at which the stress ill relieve itself. In both cases stress relieving is accomished by tension of such a value as to be above the yield int of the plate. If the vessel is heated to a sufficiently gh temperature, no tension beyond the stress itself is reuired. If the tension loading is applied at ordinary tempera-res by the application of internal pressure, a considerable alue of tension loading is required. The condition of the aterial is substantially the same after stress relieving by ternal pressure at ordinary temperatures as when the stress lieving is accomplished at 1,100 degrees Fahrenheit in a rnace.

The point might be raised, that while stressing the vessel internal pressure to the elastic limit of the longitudinal ams would eliminate residual strains in the longitudinal ams, it would not give irrefutable evidence that no residual rains existed in the girth seams. But it is of course true at twice as much residual strain is permissible in the girth ams as in the longitudinal seams, due to the fact that the orking stresses are only half as great. There is a very small egree of probability that a vessel welded by the same method roughout and leaving no deformation due to welding beyond at permissible on the drawing would leave no residual stress n the longitudinal seams and a considerable stress on the irth seams.

But assuming the worst possible condition, the net result ould be approximately the same as if the vessel were stress lieved in a furnace at 1,100 degrees Fahrenheit. As shown Figure 16, a temperature of 1,100 degree Fahrenheit would ave from 4,000 to 5,000 lbs. per square inch residual stress the seams of the vessel if any stress exceeding these values ere present after welding.

An instance may be cited as follows: A vessel with 10,000 s. working stress in the longitudinal seams. (We may

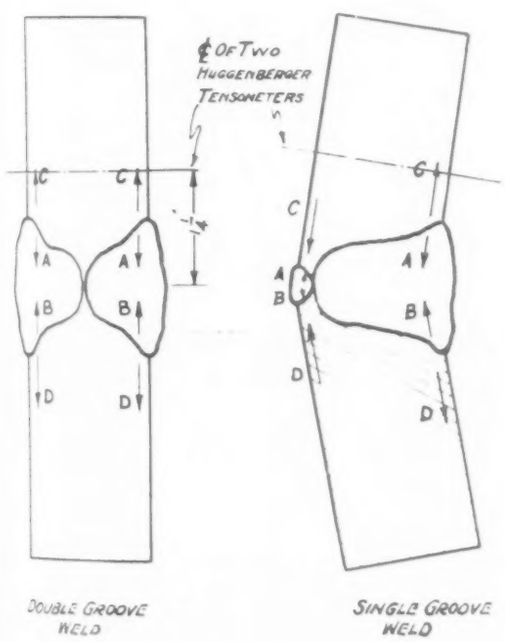


Figure 17. Residual Stress Couples in Single and Double Groove Welds.

sume elastic limit of 25,000 lbs. per sq. in.) The girth am would then have a stress of 5,000 lbs. per sq. in. There a remote possibility that 12,000 lbs. residual stress might ist and the lime wash would not scale. Under working nditions therefore, we would have 5,000 lbs. working load girth seams plus 12,000 residual making a total of 17,000 s.

In the case of stress relieving the same vessel in the furnace at 1,100 degrees Fahrenheit we would have under working conditions, 10,000 lbs. in the longitudinal seam due to working load plus 5,000 left of the residual strain making a total of 15,000 lbs. If any deformation of the welded seams were present (.030 in. gives a stress concentration of 2,400 lbs. per sq. in. on one side, the vessel stress relieved in the furnace might have a higher actual load than the vessel stress relieved by internal pressure.

The advantage of stress relieving by internal pressure at ordinary temperatures is that it is safe and relatively inexpensive. Manufacturers are familiar with the han-

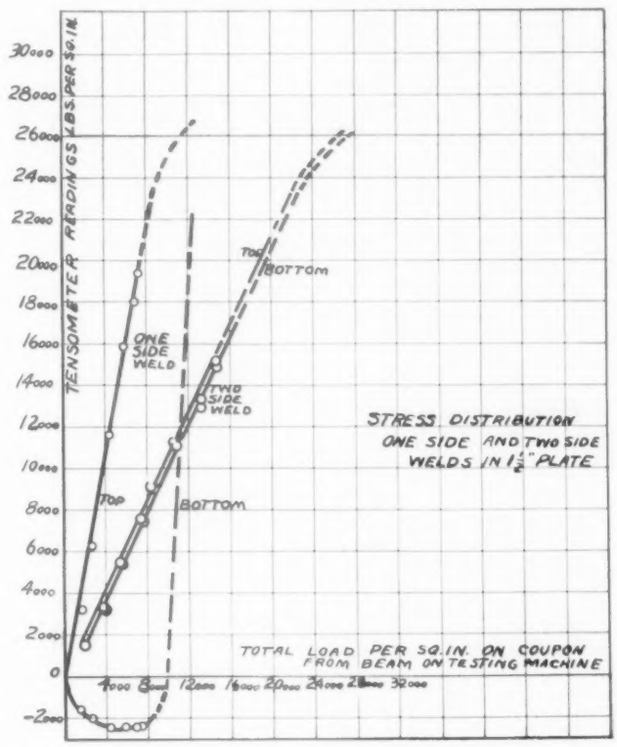


Figure 18. Stress Curves Plotted from Data Secured in Pulling Single and Double Groove Welds.

dling of hydrostatic pressure and the matter of calibrating their gages. In case an excessively high pressure is applied to a vessel, due to an accident, its shape will be improved up to the point at which failure occurs. In case of failure the damage may be repaired.

On the other hand the use of a furnace for stress relieving is an operation which requires a high degree of skill. The temperature must be sufficiently high to accomplish its purpose but not too high, otherwise the vessel will be permanently deformed in a damaging way. The lack of safety in the practice arises from the fact that it is difficult to be certain that a temperature of 1,100 degrees Fahrenheit was reached all over the vessel and that no higher temperature was reached. Inadequate supports for the vessel in the furnace or improper cooling after it comes out will result in deformations and strains which are more serious than the original stress due to welding. The tendency where this method is employed is always in the direction of not heating the vessel to a sufficiently high temperature to remove the residual strains on account of the danger of giving it a deformation of a damaging nature.

Figure 20 shows a large vessel (1½ in. shell thickness) being tested cold with high internal pressure for residual strains. The practice is simple and may be carried out in any shop which is equipped to supply sufficiently high hydraulic pressure. Considerable numbers of vessels have been tested in this way and the method found effective.

Experiments With Quenched Bars

The object of this brief experiment was to check the theory of the way in which residual stresses are created in steel bars. In the previous work, studies were undertaken in an effort to establish some rational basis upon which one might make some estimate of the situation in a given case. The state of general knowledge on the subject of residual stresses in metal due to temperature changes is so unsatisfactory that there is, perhaps, some justification for such elementary ground work. The implications of such knowledge as we have are so far reaching that there are grounds for hoping that further investigations will be made and that eventually knowledge of this phenomenon will be put in a more usable form.

These experiments were made with standard A.S.T.M. bars in which the cross section of the reduced section was approximately 1⅜ in. by 1½ in. The steel used was A.S.T.M. A-89 Grade A Flange steel for Forge Welding (Minimum T. S. 45,000 lbs.) Ladle analysis showed .13 per cent carbon.

The steel chosen was the recognized standard specification best adapted for welding with the electric arc process without subsequent annealing. No attempt was made to get the analysis of each bar for the reason that it would be quite beyond the accuracy range of the test to use the information, even if it were obtained.

Twelve standard A.S.T.M. bars, as described above, were tested. They were divided into four groups of three bars each. They are as follows:

Group I — Obtain ultimate and yield point in "as rolled" condition.

Group II — Obtain ultimate and yield point after quenching from 1,000 Deg. Fahr.

Group III — Obtain ultimate and yield point after quenching from 1,000 Deg. Fahr. and reheating to 1,100 Deg. Fahr.

Group IV — Obtain ultimate and yield point after quenching from 1,000 Deg. Fahr. Stressing through the yield point allowing to rest 24 hours.

Table I shows the results obtained from these tests.

Discussion of the Results

The bars in the "as rolled" condition show that the steel behaved in accordance with the specifications. The yield point was about 50 per cent of the ultimate strength.

The writer is aware, of course, that of the thousands of boilers and pressure vessels which have been built, by riveting, none have ever been put in service with the metal in the "as rolled" condition. In order to fabricate the shell or heads, it was necessary to stress the metal beyond the yield point, so that all boilers and pressure vessels now in ser... are made of metal which is not in the condition in which ... left the steel mill. In the case of the shells, stressing beyo... the yield point was done cold. The heads were formed h... and unless they were reheated and cooled in the furna... have received pretty rough thermal treatment. With t... hope of finding out what might happen under very u...

TABLE I

Bar No.	Area Sq. In.	Yield Point	Ultimate	% Elong. in Ins.	% Red of Area	Ratio YP/Ult.	Treatment
			GROUP III				
1.	2.053	27300	47600	39.7	63.1	57.4	Quench from 1000 F.
2.	2.049	25300	47400	40.3	63.4	53.4	Reheat to 1100 F.
3.	2.046	25200	47230	38.7	63.9	53.4	
			GROUP IV				
4.	2.052	25950	57950	28.2	57.1	46.6	Pull through Y. P.
5.	2.052	29450	57800	29.4	56.8	51.0	Rest 24 Hours
6.	2.051	25350	59200	27.8	51.3	42.9	
			GROUP II				
7.	2.057	30700	63400	21.6†	54.0	48.5	
8.	2.045	26150	57900	29.4	54.6	45.2	As Quenched
9.	2.052	27650	60150	17.9†	54.3	49.3	
			GROUP I				
10.	2.051	25350	50000	35.6	54.6	50.7	
11.	2.041	26550	50150	35.7	54.3	53.6	As Rolled
12.	2.047	24900	49900	36.0	61.5	52.1	

†Broke near Gage Marks. Elongation probably about the sa... as No. 5.

favorable conditions in this respect, the three remain... groups of test bars were heated to 1,000 Deg. Fahr. a... quenched in cold water.

Discussion

1. There are some hardening of the metal due ... quenching from 1,000 Deg. Fahr. This amount wo... not ordinarily be considered objectionable, in fa... from some points of view, it improved the metal.
2. We would not expect to find residual strain in lar... amounts in the long dimension,—the bar was free t... contract. But there might have been considerab... strain present due to contraction in a plane at ri... angles to the long dimension.
3. Within the limits of accuracy of this test, no re... dual strains were found in any of the bars teste... Had strains been present in considerable amount... the condition would have been shown by an accu... reduction in the yield point of the metal. It will b... observed that the yield point is about the same f... all of the groups of bars. If allowance is made for th... slight tempering quality of this metal, the ratio o... yield point to ultimate strength remains consta... within the range of variation of physical propertie... encountered between test bars cut from the sam... plate.

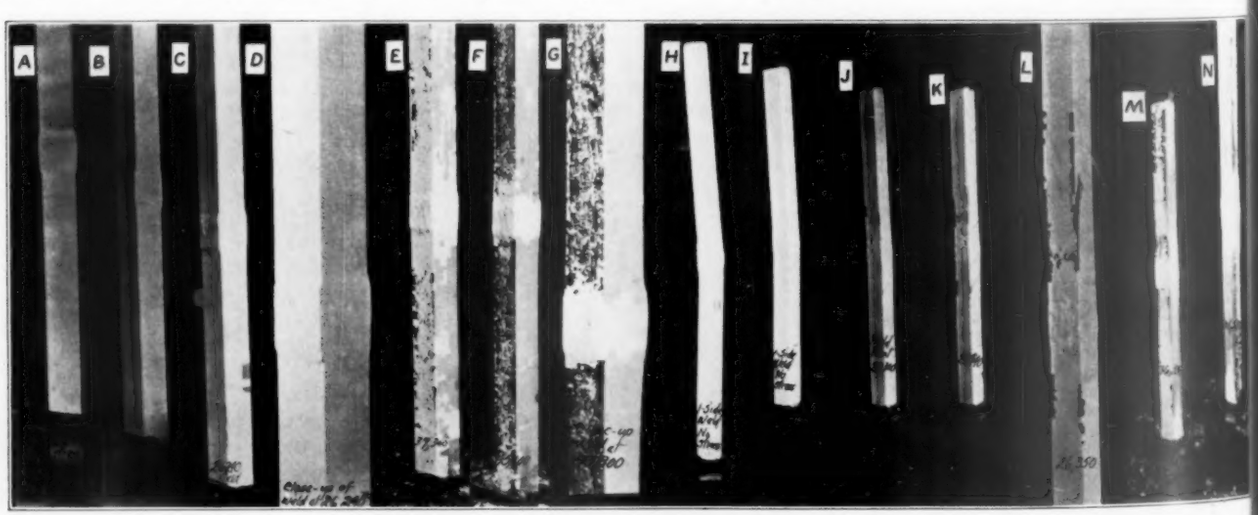


Figure 19. Lime Wash Tests Applied to Double and Single Groove Welds. Results Coincided Closely with Those Anticipated from Tensometer Tests.

A and **B**. Two Views of Double Groove Weld Under No Stress. **C**. Double Groove Weld at Yield Point—26,240 Lbs. D is a Cl... Up of Weld at This Stage. **E**, at Tensile Stress of 37,000 Lbs.; **F**, at 45,100 Lbs.; **G**, Close Up at 49,300 Lbs. Two Views of Single Gro... Weld Under No Stress Are Shown in **H** and **I**. The Yield Point (22,300 Lbs.) is Shown in **J**. **K** Shows Condition at 24,900 Lbs.; L... 26,300 Lbs.; **M**, at 36,500 Lbs.; **N** is a Second View Under the Same Stress.

4. Had there been residual strains in a direction perpendicular to the long dimension, they would have been shown in this test as readily as if the strains were in the long dimension. The resultant of cross strains would have been the same as if external compressive stress had been applied tending to shorten both dimensions. If such a resultant strain were present, it would be shown by the fact that less tension would be required to elongate the bar.

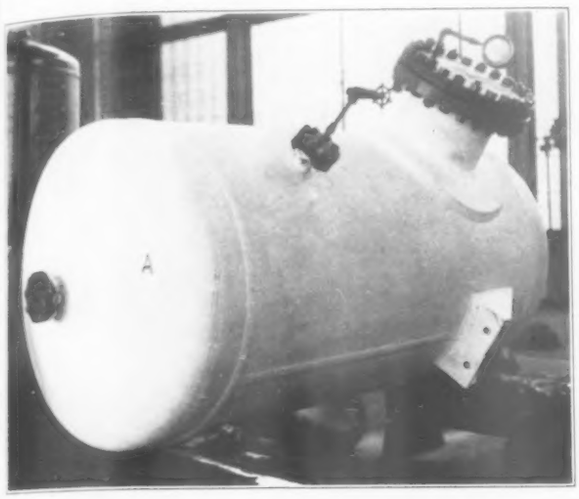


Figure 20. Pressure Vessel with 1½-Inch Shell Undergoing Internal Pressure Test for Residual Strains.

5. A possible explanation for the lack of residual strains in the dimensions perpendicular to the long dimension of the bar may be as follows:

   The cooling rate was so rapid that the metal at the center of the section was stressed beyond its yield point (which would be low due to high temperature) during practically the whole time interval of cooling. When the center finally cooled, such a short dimension of metal was stressed as to produce strains so small as to be immeasurable by this method of testing.

   If this explanation of what happened can be conclusively proven to be correct, weld behavior in this respect also becomes understandable because we have the same high speed, progressive cooling in the weld metal as was encountered in quenching these bars.

6. In certain cases, the residual strains in a weld are below measurable limits when they might be expected to be very high. The tentative explanation of the phenomenon will bear further examination and checking. If the explanation is correct, it opens the way to still further improvement of welding technique.

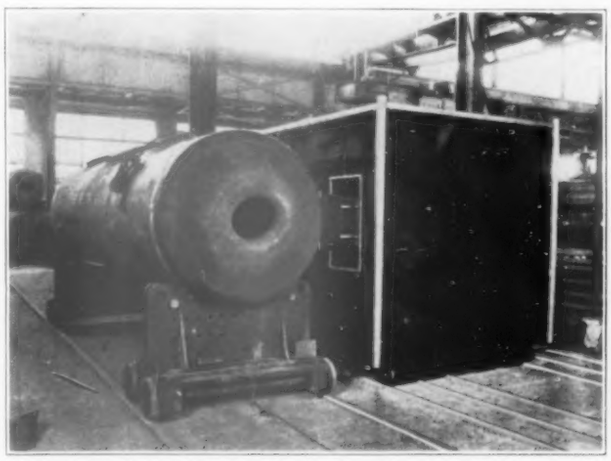
General Conclusions

1. The amount of residual strain in a weld joint depends on how the joint was welded. Different methods leave different amounts of residual strain and the value may be so low as to be immeasurable by ordinary methods or may be so high as to cause failure of the joint before the welding operation is completed. The procedure tested in this work involving ductile metal in the weld and a certain stated sequence of operations has been confirmed to a considerable degree by the wholly independent investigations of C. H. Jennings of The Westinghouse Research Labs.
2. These investigations tend to show why the several hundred pressure vessels built by this approved welding procedure, without stress relieving in a furnace, continue to give satisfactory service. In three years, none have failed.
3. The actual experience and this investigation bears on plate thickness up to and including 1½ inches. It is felt that additional investigation would be required to weld plate of greater thickness without stress relieving in a furnace before the weld is completed. In all probability it can be done successfully.
4. The matter of stress relieving, welding procedure to eliminate its necessity, and methods other than heating in a furnace should receive careful consideration on the part of engineers and designers. If it is not safe to weld a pressure vessel without reheating in a furnace, it is not safe to weld a building, a bridge, or a ship. It will be much less expensive for industry to utilize a welding procedure which does not require reheating in a furnace when possible than it will be to install expensive reheating furnaces which may become obsolete in a short time. The future development of welding practice will require the installation of hundreds of furnaces for annealing but the unnecessary installation of furnaces for stress relieving would prove a heavy burden, particularly in the case of pressure vessels where there is convincing evidence that stress relieving by internal pressure in combination with suitable welding procedure yields an entirely satisfactory result.

New Boiler X-Ray Equipment Radiographs 34 Inches at Once

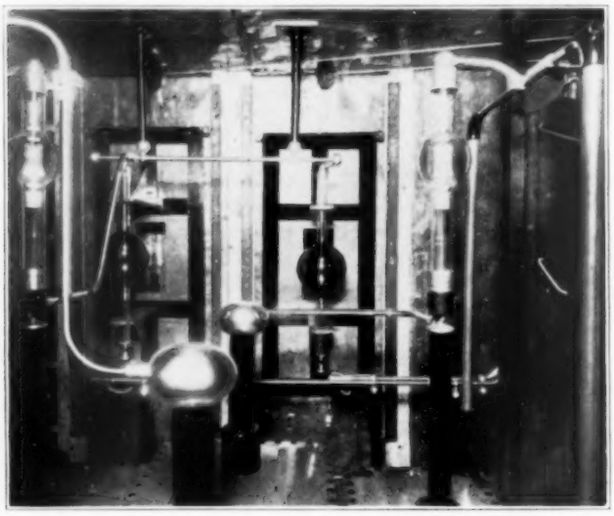
Since the use of X-rays has done much to enable a manufacturer to know more about the result of his process of fabrication, the Hedges-Walsh-Weidner Company of Chattanooga, Tennessee, have had recently installed by the General Electric X-ray Corporation of Chicago, what is said to be the highest voltage mobile X-ray equipment yet developed for the radiography of welded pressure vessels, with capacity for radiographing a thickness of boiler plate up to five inches.

Heretofore, most industrial installations have been of the stationary type, but because of the flexibility required to radiograph all welded seams on 11 sizes of vessels to meet the new specifications of the Boiler Code, the mobile type was considered best adaptable. This new equipment, including all high voltage transformers, meters, tubes, etc., is mounted on a truck in a lead-walled container, 6½x6½x8 feet, as a protection against both high-voltage and X-ray. The truck operates on a system of tracks fifteen inches apart. With a lateral shift of the container itself of two feet the inspection of any diameter vessel of present dimension or future consideration can be easily arranged.



Making Radiographs of a Boiler Shell.

The side of the container which faces the pressure vessel to be radiographed has two small apertures from which the X-rays emerge, directed by two small cones which constitute the only projection on this surface. These cones are removable and can be placed at 90 degrees in order to take care of circumferential radiography. It also provides for the use of any length of cone that is demanded by projections on the vessels, such as nozzles, etc.



Inside of Container Showing Two X-Ray Tubes.

The novel feature embodied in this new design is the operation of two X-ray tubes at the same time enabling thirty-six inches of welded seam to be radiographed simultaneously. The two X-ray tubes have a raising and lowering device capable of a fifteen inch shift and can be raised or lowered independently of each other by controls on the control panel side of the container.

This equipment is capable of radiographing two-inch boiler plate in fifteen seconds. In actual operation a boiler seventeen feet long with one and one quarter inch wall thickness, was radiographed in fifteen minutes, which includes the time necessary for the changing of the cassettes.

An up-to-date darkroom has been installed in close proximity to where the radiography of the pressure vessels takes place. It is built with a maze, thereby eliminating all doors and is equipped with a film drier which facilitates the handling of films in large quantities and enables a complete inspection from dry films in thirty minutes.

Bronze Weld Saves Long Shut Down in Gold Mine

One day last winter the San Francisco district office of the Air Reduction Sales Company received a long distance telephone call from a large gold mining company. The main water pump in their mine, of 800 gallons per minute capacity, had broken down and the two emergency water pumps were of insufficient capacity to keep the water level in the mine down. To get a new main water pump would require weeks. The mine would be greatly damaged if it filled with water, and the crew of over 200 men would suffer a lay-off. Their own mechanics were not able to weld the broken pump cylinder, and the officials were very much worried because they did not feel that welding was feasible.

The situation was so urgent that a service man from the Applied Engineering Department was called in from an outlying district and he traveled most of the night to reach the mine. Arriving at the mine, he found one whole side broken out of the center cylinder of a triplex pump, stuffing-box and all. Another crack ran the full length of one of the outside cylinders and continued in a circular direction around the base. A crew of men, furnished him by the Master Mechanic, aided in removing the pump from the mine and dis-assembling it. The pump cylinder weighed approximately 2,000 lbs. and was awkward to handle. Setting the broken piece in place for welding was also difficult. Wood was the only fuel available for preheating the casting, this being considered advisable under the circumstances.

However, a large preheating furnace was built of sheet steel and the fire lighted at 10:30 A. M. the same morning. Welding was started at 2:00 P. M. and completed at 4:45 P. M. The following list includes the principal data for the operation:

Welding time for center cylinder inlay	1 hr. 20 min.
Welding time for outside cylinder crack	0 hr. 45 min.
Total	2 hr. 5 min.
Total acetylene consumption	50 cu. ft.
Total oxygen consumption	50 cu. ft.
Total bronze rod, ¼ inch	10 lbs.
Total flux	½ lb.
Total wood used for preheating	1 cord

Style 8800 Airco-D.B. torch, long extension, No. 9 tip, 10 lb. regulator pressure.

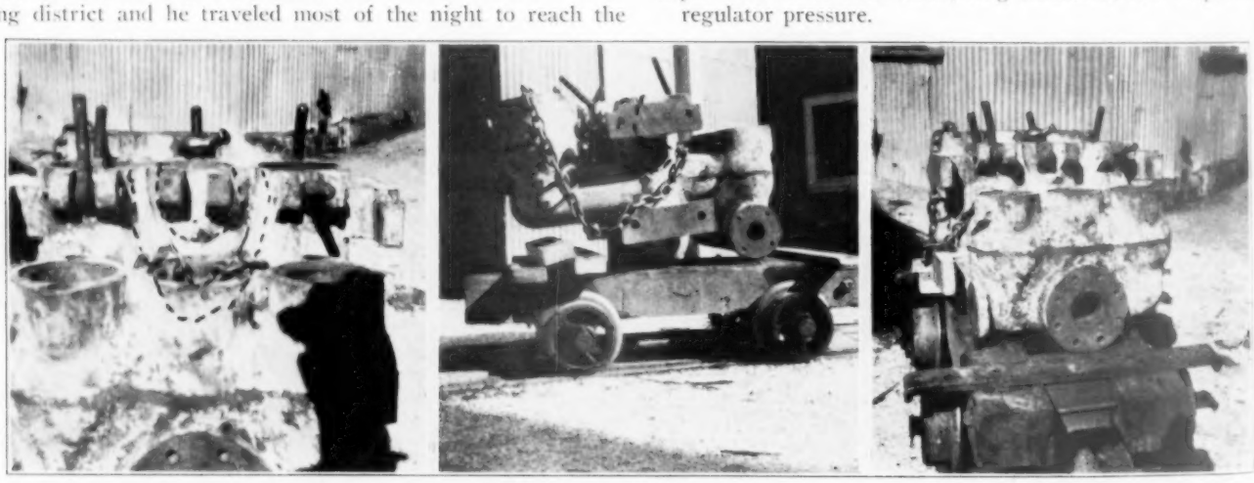


Figure 1. (Left) Dotted Lines Indicate Area of Weld in Center Cylinder. Figure 2. (Center) Weld in Outside Cylinder. Figure 3. (Right) The Unit After Welding Was Completed.

After welding, the casting was replaced in the fire and left there until the following morning. Figs. 1, 2 and 3 show the cylinder after removing from fire. The dotted lines in Fig. 1 indicate the weld area of piece welded in center cylinder while the crack welded in outside cylinder is similarly marked in Fig. 2. The pump was again assembled, installed in place in the mine and in active service by noon, before a dangerous water level in the mine had been reached. The welding was a complete success, and saved thousands of dollars.

Welded Aluminum in Tank Trucks*

Lighter Weight Makes Increased Pay Load Possible—Tests of Correct Welding Procedure Indicate Ample Strength

By W. M. Dunlap†

DURING the past few years aluminum and its alloys have become important materials of construction in the transportation field. These metals are now being used extensively in the construction of tank trucks, trailers and semi-trailers of various sizes and designs. The light weight of aluminum is the important factor in this particular field, while the high corrosion resistance of the metal is of secondary importance.

The limiting factor in the size of trucks and trailers, in practically all cases, is the weight permitted by the highway laws in the various states. Any saving that can be realized in dead weight, therefore, provides a means of increasing the pay-load and giving a larger return on the investment. Hence, aluminum, because of its light weight, is one of the most economical materials from which to construct gasoline tank trucks.

Weight and Pay Loads

For purposes of comparison, we may consider a 750-gallon aluminum tank recently built and mounted on an aluminum alloy trailer. The weight of the aluminum tank was 1,935 pounds as compared with 3,345 pounds for a similar steel tank. The weight of the aluminum alloy trailer was 1,600 pounds, while the steel trailer weighed 2,100 pounds. This gives a total weight saving of 1,920 pounds in the case of aluminum construction. The pay load for each tank would be 750 gallons of gasoline at 6.2 pounds per gallon and two 55-gallon drums of oil at 465 pounds each, or a total pay-load of 5,580 pounds, making the gross loads for aluminum and steel units 9,115 and 11,035 pounds respectively. If the savings in dead weight of 1,920 pounds had been utilized to increase capacity, the aluminum tank would have held an additional 300 gallons of gasoline.

We might also consider some aluminum tanks of greater capacity. A number of aluminum tanks of 2,400 gallon capacity have recently been built. These aluminum tanks weighed 2775 pounds as compared with 5,545 pounds for steel tanks of 2,000-gallon capacity.

A 400% Return

The transportation cost for tank truck delivery of gasoline varies from $.004 per gallon for short hauls to $.04 for long hauls. One large oil company states that $.01 per gallon is a fair average figure for city delivery, and that a tank such as mentioned above should average five trips daily in such service. The 400 gallons increased capacity for the aluminum tank might, therefore, mean an increase of 2,000 gallons delivered daily, or a net saving of $20.00 per truck per day. If we assume that a 2,400 gallon aluminum tank sells for $3,000.00 or twice as much as a 2,000 gallon steel tank, the added investment of $1,500.00 would be written off in 75 days. Again assuming the price of the aluminum tank to be $3,000.00, which is probably high, the saving writes off the entire cost of the tank in 150 days. This is a return of 400 per cent per 300 day year on the added cost of the aluminum tank.

As previously stated, weight saving is the important factor in the transportation field. This saving may be utilized by increasing the capacity of the tank and hauling a greater payload for the same gross load, or by reduction in gross load to permit the use of smaller and less expensive trucks. This results in lower operating and maintenance costs. With less gross weight, the increased tire mileage becomes quite an item. Even with an increased capacity for the aluminum tank, there will be a lower operating cost on return trips with the empty tanks. Whether an increase in capacity with the same gross weight, or the same capacity with a decrease in gross weight, or a combination of the two is the most economical depends largely upon the service for which the tank is intended. For large units, the capacity increase is preferred, while for the small tank used principally for short-haul distribution to local filling stations, increased capacity is not important. This type of equipment is often idle part of the day, particularly during the winter. The decreased gross load with its attendant advantage of a lower priced tractor would, therefore, take precedence.

Capacity and Weight

The stresses to which a truck tank is subjected on the highway cannot be accurately measured or calculated. Therefore, the present day practice is to use the proved design of steel tanks as a basis of re-design for the aluminum-tank, substituting the proper thickness of aluminum plate to make the tank as rigid as in steel. This means increasing the gauge by the cube root of the ratio of the modulus of elasticity of steel to that of aluminum or an increase of 40 per cent in thickness. Even with this increase in thickness of material, the weight of an aluminum tank of 2,400 gallon capacity is about half that of a steel tank of 20 per cent less capacity.

How Aluminum Tanks Stand the Test

A series of typical tank sections made of aluminum have been subjected to a series of tests in order to determine how aluminum tanks would behave as compared with steel tanks under various conditions. Six 150-gallon eliptical aluminum tanks were tested. Three of these tanks were made with 0.141 inch 3S[1] half-hard heads and 0.109 inch 3S full-hard shells. These are the thicknesses commonly used for steel tanks of similar capacity. The other three tanks were constructed of sheet approximately 40 per cent thicker, or 0.204 inch 3S half-hard heads and 0.156 inch 3S full-hard shells. The shells were butt welded by means of a torch with one longitudinal weld, which was dressed by hammering. The heads were flanged approximately one and one-half inches and torch welded to the shell, using a butt-type weld. A six-inch half coupling was welded to the shell at the middle of the longitudinal seam.

The light gauge (0.141 in. heads and 0.109 in. shells) aluminum tanks weighed 73 pounds each. The heavy gauge (0.204 in. head and 0.156 in. wall) aluminum tanks weighed 105 pounds each. The steel tanks weigh 215 pounds each.

In the first test, which was a drop test, one light gauge and one heavy gauge aluminum tank was filled with 150 gallons of water and dropped from a height of 10 feet to a steel plate on the concrete floor. The light gauge tank wrinkled badly, but did not leak. The heavy gauge tank did not wrinkle; however, it did distort and flatten out where it struck the floor, but it did not leak.

Another heavy gauge tank was filled with 150 gallons of water and dropped from a height of 25 feet to a steel plate on the concrete floor. The tank wrinkled about as badly as the light gauge tank did on a drop of 10 feet, but it did not leak.

A fire test was made by filling a light gauge tank half full (75 gallons) of gasoline and building a fire beneath it. The fire was fed by a one-half inch oil line, and was confined

*Extract from a paper read before the 31st annual convention, International Acetylene Association, Chicago, Illinois, November 12, 13, 14, 1930.

†Aluminum Research Laboratories, Aluminum Company of America, New Kensington, Pa.

(1) Commercially pure aluminum plus 1.25% manganese.

by a steel shell enclosing the lower half of the tank in such a manner as to direct a very hot flame directly on the aluminum. Shortly after the fire was started, the fusible plug in the cover of the aluminum tank melted out. The gasoline fumes ignited and continued to burn until the tank was dry.

A heavy gauge tank was tested by hydrostatic pressure to 148 pounds per square inch and showed no signs of failing or leaking. A rubber gasket blew out at this pressure, making it impossible to test the tank to destruction.

These tests demonstrated fully that aluminum gasoline tanks are able to stand up satisfactorily under the most rigorous service a tank truck is likely to encounter.

What Aluminum Alloys Are Used

At the present time most aluminum tanks are fabricated from the alloy 3S as this alloy has a high corrosion resistance, is easily fabricated, and has sufficient strength for the purpose. Piping used on the tank is usually of the same alloy, while most of the cast fittings are 43 alloys[2]. Supporting members, trailer chassis, and similar parts where strength and rigidity are important are usually made from one of the heat treated aluminum alloys of the duralumin type. This material is used in the form of plate and structural shapes.

In the fabrication of aluminum tank trucks welding is always used on the tank proper. Welding produces a dependable gas-tight joint, and is somewhat lighter than riveted construction.

The Butt Weld Is Recommended

For aluminum tank work, the straight butt type weld is recommended in preference to the lap weld that is used in steel tanks. The butt weld is more satisfactory for aluminum and increases welding speed considerably; furthermore, there is not so much danger of entrapping flux in the weld. Aluminum tanks should be so designed that welds are not made on corners or immediately adjacent to bends. The flanges on the heads should preferably be at least three inches deep. The heads and shells should be accurately formed so that the parts fit closely together. Wide gaps in the joints can be bridged with the torch and filler rod, but it is far more economical to use care in cutting and forming the parts. Complicated welds should be avoided and fittings should be kept separated enough that the welds do not overlap.

Most of the aluminum plate used in tank construction is from ⅛ inch to 5/16 inch thick. The ⅛-inch material is usually prepared for welding by notching the edges. The notches are made with a cold chisel and are usually about 1/16 to ⅛ inch deep and about 3/16 inch apart. Material thicker than ⅛-inch should have the edges beveled to form a 90° vee. The bevel should not be carried entirely through the sheet, but about a ⅛-inch lip should be left. On very heavy material it may be advisable to use a double vee type of preparation and weld from both sides.

In setting up the work for welding, spacing of any kind is avoided. Long seams should be tack welded at intervals of from 5 to 8 inches. All tack welds should be "fused in" well, and when widely separated should be two or three inches long.

Aluminum Tank Welding Procedure

In assembling the tank, the normal practice is to complete the welding of the longitudinal seams and all shell sections before beginning the tank assembly. One head and its adjacent shell section are then clamped together and the circumferential weld made after the head has been securely tacked so that it can not warp out of position. As flat or horizontal welding is normally practiced on aluminum, the tank should be set on rollers during the assembly, so that the welder can sit or stand in one position directly above the seam and weld continuously while the tank is rotated for his convenience. Fastenings to be welded to the heads should be put on before the assembling of the tank, while those on the shell can be attached afterwards.

When welding has been completed, the flux should be carefully washed from the tank. Aluminum oxide is highly resistant to chemical and thermal action and for this reason any flux that would remove the oxide would attack the aluminum underneath. If the flux is not completely removed it will continue to corrode the tank after it has been placed in service. Furthermore, flux remaining on the seam will cause the paint to blister and peel off. Warm water and a vigorous application of a stiff scrubbing brush is a very good means of removing flux, while for corners and crevices where flux may be entrapped, a steam jet, closely followed by a stream of water, is very good. Soaking in a warm aqueous solution of from 3 to 5 per cent nitric acid or sulfuric acid is probably the safest means of flux removal. The acid bath should be followed by a rinse in water.

After the flux has been removed, the weld should be finished by grinding, or by chipping or hammering, in cases where a smooth surface is desired. In most large tanks, however, the welds are left as made. These welds, when properly made by a trained aluminum welder, are very even and are not at all unsightly. Unless it is especially desired to have a smooth, flush surface, the welds should be left as made as grinding or chipping is an expensive operation, and, furthermore, the added thickness of metal in the weld proper acts as a stiffening and strengthening rib.

Welding On Cast Aluminum Fittings

Many of the fittings used on tanks are castings, and are usually cast from 43 alloy. For welding these castings to the tank, a welding wire of the same composition as the casting and of the same characteristics should be used. No 43 welding wire is usually known as 5 per cent silicon welding wire. The technique for welding castings is substantially the same as that used on sheet, but care must be exercised to secure more uniform expansion and on large intricate castings, total preheating is often required. This preheating, however, should never be carried above 800° F—from 750 to 800° F is recommended. A common method for testing the temperature of castings during perheating, when pyrometric equipment is not available, is to put a chalk mark on the casting with a piece of carpenter's blue chalk. At the proper temperature for welding this blue chalk mark will turn white.

This paper has set forth the more important points or highlights to be taken into consideration in the welding of aluminum gasoline tank trucks, pointing out such things as deep flanging, fitting of joints, composition of welding wire and flux, that will cause serious trouble if not taken into consideration and properly treated. As the builder of aluminum tank trucks gains experience in handling this material, finds that its characteristics are somewhat different from those of steel, and adapts his design and technique to these characteristics he will observe a diminishing difference between the costs of aluminum and steel fabricating.

The manufacture of aluminum truck tanks is still in its infancy, and as we all gain experience in this field we shall learn much that will enable us to build these tanks with an even greater facility than at present.

(2) 95% *aluminum*, 5% *silicon*.

Pamphlet Gives Safety Rules For Structural and Tank Shops

A pamphlet entitled, "Safety in Structural and Sheet Metal Fabrication," comprising thirteen illustrated pages of safety suggestions for shops engaged in structural steel fabrication or sheet metal fabrication has recently been published by the National Safety Council, Civic Opera Building, Chicago, Ill. This pamphlet has been prepared by a special committee on structural and metal fabrication of the American Society of Safety Engineers, the engineering section of the National Safety Council. It has also been approved by special committees of the leading safety engineers of the country. It deals with the causes of accidents in two types of shops where welding and cutting operations are pretty certain to be a part of the regular program. The causes of injury given do not

involve welding to a very large extent, a good many of them being cuts and bruises and abrasions, and a good many of them being caused by the improper handling of other tools besides welding and cutting equipment. However, the pamphlet does point out the precautions which must be taken to avoid personal injury in connection with welding operations, particular reference being made to eye protection and to the proper handling of compressed gas equipment. The pamphlet covers such a wide range of things which have caused personal injury to workmen that it should be read carefully by all foremen and supervisors in the two types of shops for which it was prepared.

Arc Welded Steel Frame at Cost of Wood Framing

By C. M. Taylor†

A DESIGN for arc welded steel framing which eliminated shop fabrication, made possible erection without derricks or gin poles, allowed superior wall and ceiling construction, has attracted building experts and engineers to Cleveland's exclusive Shaker Heights district where an arc welded steel frame house was recently completed. Not only has this type of construction been acclaimed as far superior to traditional framing but it is no more costly.

The house in question was designed for both wood frame and arc welded steel construction by George Howard Burrows, A. I. A., prominent Cleveland architect, who asked con-

Figure 1. Artist's Sketch of Seven-Room Steel-Frame Residence.

tractors to study his design and submit bids for either type of building. In only six items did these bids differ.

	Wood Framing	Steel Framing
Structural Steel (erected)	$ 180.00	$ 881.50
Rough Lumber	1,185.00	432.00
Carpenter Labor	1,400.00	1,000.00
Plastering	800.00	615.00
Wiring	335.00	420.00
Masonry	2,820.00	3,395.50

The tremendous advantages of steel framing cost but $24 more for this seven-room residence, illustrated in Figure 1.

House Not an Experiment

Architect Burrows has studied arc welded steel construction for six years. The structural plans for this house were approved by Louis K. Whitcomb, structural engineer for the Carnegie Steel Company, and Lee H. Miller, chief engineer of the American Institute of Steel Construction. The house is notable because it is not a freak combination of radical building methods and materials but merely the assembly of engineering principles tried and proven in other types of construction. The architect has applied sky-scraper engineering to residence construction and, with the aid of the electric arc process, has been able to keep the cost as low as wood framing.

The Norman-French architecture of the house set up a rigid test for the versatility of arc welded steel framing. A steep pitched roof, varying floor levels, and several offsets in the exterior wall combined to complicate the framing.

Steel Used Like Lumber

The basic principle behind the economies of the architect's design is that the steel is used just like lumber. Standard structural shapes, cut to length at the mill, were delivered on the job without previous fabrication. Three iron workers, one of them a welding operator, aligned the members and welded them into position just as lumber is erected. In order to facilitate handling, no heavy members were ordered in lengths of over 25 feet. While this necessitated some additional welding to splice long members, the need for derricks or gin poles was eliminated and erection simplified.

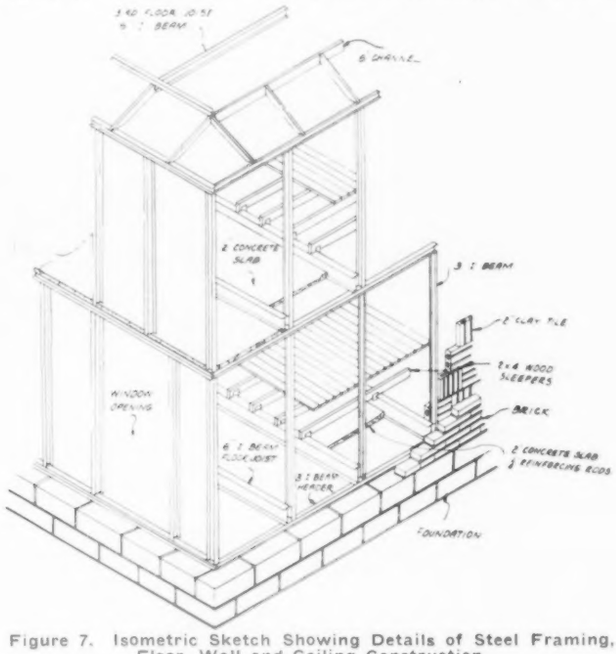


Figure 7. Isometric Sketch Showing Details of Steel Framing, Floor, Wall and Ceiling Construction.

The steel used consisted principally of 3 inch—5.7 lb. Carnegie I-beams which served as sills, 3 inch—4.1 lb. channels which served as studs and 6 inch—12.5 lb. Carnegie I-beams which served as floor joists. Figure 2 shows how the sills were laid on the masonry foundation walls. The floor joists were then secured to the sills with short tack welds. Where the span was too great the floor joists are carried on 8-inch I-beams supported by 4-inch I-beams which act as basement columns. Studs were fused into the sills with fillet welds along the inner faces of the channel.

How the steep pitched roof complicated the framing is shown in Figure 3. The rear masonry wall is carried by angles welded to the floor joists on the second floor. A reduction in the area of the third floor required the framing

†Vice-President, The Lincoln Electric Co., Cleveland, Ohio.

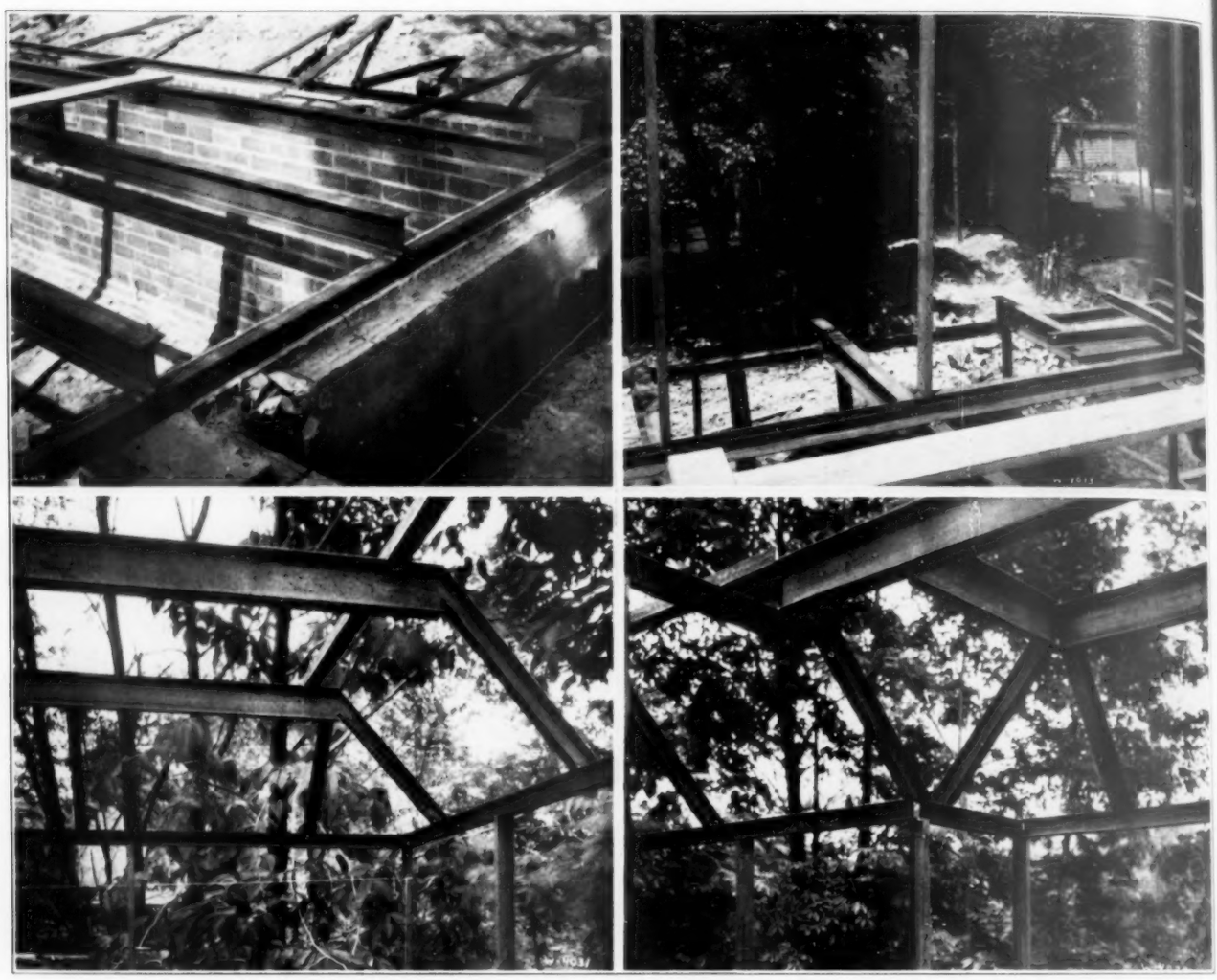


Figure 2. (Upper Left) Sills and Floor Joists, Showing Tack Welds. Figure 3. (Upper Right) Angles Tack Welded to Second Floor Joists Carry a Masonry Wall. Figure 4. (Lower Left) Framing for Third Floor. This Was the Only Type of Connection Fabricated on the Ground. Figure 5. (Lower Right) Complicated Framing Around Offset in Front Exterior Wall.

shown in Figure 4. These connections, with the weld in shear, were fabricated on the ground prior to erection. A view of the same framing around an offset in the front exterior wall is shown in Figure 5. The connections were made with a minimum of cutting. It is the contention of the architect that steel is as easy to frame as lumber: on this house his contention was not disproved. All cuts were very simple.

Fig. 6. Detail of Wall Construction.

The arc welded steel frame allowed the use of the hollow enclosure brick and tile wall shown in Figure 6. This wall consists of 2 inches of hollow tile and 4 inches of face brick separated by the steel studs which allows a 3-inch dead air space to insure insulation. Both masonry shells are tied to the frame with clips wedged to the flange of the studs. The face brick is reinforced laterally with steel pencil rods. The Common Brick Manufacturers Association of America has awarded its certification of excellence to this wall. Figure 7, an isometric drawing, shows the details of construction. The steel floor joists are protected by 2 inches of reinforced concrete which serves as a ceiling. Wood sleepers laid across the floor joists carry the sub floor and allow wiring and piping in either direction.

Building experts have long predicted a trend toward steel framing which has never materialized. Arc welding, however, has made possible a design for a steel frame house which embodies the best accepted engineering principles and yet competes with wood frame construction in price. Because of the permanence and durability of this type of house it will find favor with banks and mortgage companies. Its design is not so radical as to cause prospective builders to be wary of it.

It is estimated that with this type of construction, with the eventual adoption of "battleship deck" flooring and the innovation of a low cost steel roof construction, a potential market for 3,000,000 tons of structural steel will be developed. This is larger than any single outlet now existing for structural shapes.

Resistance Welding Data*

How Transformer Capacities Are Figured for Flash, Spot and Projection Welding—Effect of Changing Material to Be Welded—Influence of Pressure and Welding Speed

By Walter Anderson† and Malcolm Clark††

WHEN an engineer has a job that requires electric resistance welding, the first step should be to analyze the job from several angles just as the medical men will diagnose a case before prescribing a cure. He must go into the production required first, then second the strength required in the weld, third, convenience of handling work to the welding machine, and fourth, the cost of welding equipment.

In order that we have a proper understanding, let me say that the term "Electric Resistance Welding" covers any and all types of welding machines where the electric current is made to flow through the metal to be welded, this metal being supported between two electrodes or dies.

Butt Welding

Regarding the possibilities of butt-welding, there really is no limit to what can be welded by this method, the only thing that would offer any limitations being the size of the welding machines that could be built, and the electric power available to operate the machine after it has been built.

We have seen round steel bars, with a cross sectional area of 70 square inches, being butt-welded, and the fusion was so perfect that the weld was just as strong as the original bar of steel. Then again, we have seen a welding machine that butt-welds 16 gauge steel plates 120 inches wide; this is a production job.

A large well-known manufacturing company is putting in a machine to butt-weld plates 110 inches long with a total cross-sectional area at the weld of 55 square inches. This also is a production job. Our company has received inquiries for welding machines to be used for welding greater areas than those mentioned, so really the field is unlimited as far as size is concerned.

We all know what has been accomplished by the resistance welding method in regard to making tubing and pipes. The cost of making tubing has been very substantially reduced by this process and there are many other fields of development for resistance welding that have not been tried. These will offer just as great, if not greater, possibilities than the pipe field, and they will undoubtedly develop very rapidly in the near future.

We might give some general data for resistance butt-welding, which perhaps would be of help to the engineer who is planning on a welding job. The figures are based on an automatic welding machine, either mechanically operated by cam, or hydraulic automatic, and worked on a production basis, that is, running continuously as fast as the work can be handled.

Of course, it is fully understood that where a machine only makes one weld, and then is idle long enough for the transformer to cool off, or where the machine is operated manually so that plenty of time can be taken to allow the heat to soak slowly into the metal, you can get by with much less transformer capacity than would be required on an automatic machine working at production speed.

A solid bar of round or square stock requires much less transformer capacity for each square inch to be welded than does a lighter gauge stock where the material is spread out over a larger area. The same applies to butt-welding pipe. It also requires more pressure to the square inch at weld for light stock spread out than for solid heavy stock. The upset pressure must also be applied quicker for the light stock, as it has a tendency to cool off so much more rapidly and the upset pressure must be applied when the temperature is right for fusion in order to obtain the proper weld.

We will take our unit of electric power in the welding transformer as KVA, meaning kilo volt ampere, and then taking three specific examples of transformer capacity and upset pressure required to make a perfect weld automatically at production speed.

Example No. 1—A fairly heavy job is a five-inch diameter round steel bar. This has a cross section area at the weld of approximately 20 square inches. A bar of this size would require a welding transformer capacity of 40-KVA for each square inch area of weld, or a total of 800-KVA.

A transformer of this capacity is required in order that the secondary voltage will not drop when the ends of the bars to be welded first make contact, causing a dead short on the transformer. If the transformer has not sufficient capacity to withstand the heavy surge load, the secondary voltage will drop so far that the metal will not start flashing. But if an ampere meter is placed on the primary line with a transformer of 800-KVA capacity welding five-inch diameter bar, it will be found that the consumed load on the dead short at the start of the weld will be approximately 75 per cent of the transformer capacity, or 600 KVA.

This is only an instantaneous peak load, and the consumed load during the flashing period will be approximately 45 to 50 per cent of the transformer capacity, or 270 or 300-KVA. The upset pressure must take place after the flashing is finished and just as the current is being turned off the transformer. This should be 5,000 pounds per square inch, in other words, 100,000 pounds or 50 tons.

Example No. 2—Take a 6-in. standard pipe which is 6⅝ in. OD with a wall thickness of 9/32 in. This has a cross sectional area of approximately 5⅝ square inches, and would require a transformer capacity of about 70-KVA for each square inch, or a total of 400-KVA in the welder.

The consumed load would be proportionally the same as in Example No. 1. The upset pressure for a pipe weld of this size would be approximately 6,000 pounds per square inch, or a total pressure of approximately 34,000 pounds or 17 tons.

Example No. 3—Consider butt-welding light gauge stock as in automobile body welding. Take a butt-weld seam 60 inches long in 18 gauge metal. This would have a total cross-sectional area of 3 square inches, and should have a transformer capacity of 125-KVA per square inch or a total of 375-KVA. The consumed load here would also have similar proportions to Example No. 1. The upset pressure should be about 7,000 pounds per square inch or a total of 21,000 pounds.

With the foregoing representative examples as a guide, an engineer must still use his best judgment in determining the proper transformer capacity and pressure required for his particular job.

The butt-welding of non-ferreous metals has made wonderful advances in the last few years, and it has been proven practical to miter weld the corners of window frames made of brass and aluminum. The procedure in welding these alloys is much different from that followed for welding steel, in fact we do not consider it commercially possible to weld

*Paper read before the American Welding Society, Chicago Section, May 1, 1931.

†Vice-president, Taylor-Winfield Corporation, Warren, Ohio.

††Chief Engineer, Taylor-Winfield Corporation.

these on a hand-operated machine, or even on a cam-driven unit. We have worked out a special automatic welding device, however, which is operated by springs and air cylinders, and by attaching this welding device to a welder with the proper size transformer, practically any non-ferrous metal can be commercially welded.

There is one thing worthy of mention in connection with connecting up a resistance flash butt welder to the power lines and that is, to do justice to the welding machine the capacity of the transformer on the power line where the single phase AC current is taken should always have a capacity for at least one-third more than the welding machine transformer, and with the power cables leading to the welder of ample size so that the primary voltage at the welder will never drop over 5 per cent with the surge load when the welder is operating at capacity.

Spot Welding

Spot welding is probably the simplest of the different forms of resistance welding, and ordinary steel that is free from scale does not present any real problem for this type of welding. It is merely a matter of choosing a machine with the proper transformer capacity for the thickness of stock required to weld, and one having plenty of spring pressure conveniently adjustable to give correct welding pressure, which will vary with the diameter of electrode at the weld.

The transformer capacity required in a spot welding machine for clean steel stock is worked out on the basis of 10-KVA for each ⅛ in. total thickness of the two pieces to be welded together. That is, if the total thickness is ¼ in., then 20-KVA is required, or double that required for ⅛ in. total thickness.

These figures are based on a machine with 12-in. throat depth, that is, the distance from the weld back to the transformer between the leads. If the throat depth is 24 in., the foregoing figures will be doubled. In other words, the transformer capacity is in direct proportion to the throat depth.

As we said before, spot welding clean steel stock is a simple procedure, but if we have very scaly stock we must use different figures altogether because scaly stock requires much more pressure on the electrodes than does clean stock, and the secondary voltage must be somewhat higher.

This is required as the current must be made to break through the scale, and we all know that scale, which is oxide of iron, is a good insulator. Another thing we must remember when spot welding scaly stock is that once we increase the pressure on the electrodes we must also increase the transformer capacity. In this way we see that very scaly stock will require approximately double the pressure on the electrodes and double the transformer capacity that would be needed for clean steel stock.

We are confronted with another problem in the spot welding of non-ferrous metals. Since most of these are alloys, it is hard to set up a specific rule, especially for the aluminum alloys. It is true, however, that practically any non-ferrous alloy can be welded successfully, but of course it requires much greater transformer capacity than steel. We would say that aluminum requires *twice* as much transformer capacity as steel, brass, *two and one-half* times as much, and copper *three* times as much.

The speed that can be obtained with a modern spot welder is remarkable. Machines have been operated as fast as 300 welds per minute, and we have several machines out that are operating from 150 to 200 strokes per minute. We might say here that the limiting factor in speed of a spot welder is not the machine itself, but rather the electric switch. The electrical companies who manufacture magnetically-operated switches would find a very large field at present if they would or could develop a switch to operate at double the present speed.

Projection Welding

Probably the latest, and by no means the least, development in resistance electric welding is what is termed projection welding. This name is given because projections made by punch press are put on the stock before welding. One projection, or small button if you will, is located wherever a weld is required, these buttons being made with a diameter on the face of the stock equal to the thickness of the stock, and to project above the face of the stock a distance equal to about 60 per cent of the stock thickness.

A great number of projection welds can be made at one time, there really being no limit other than the size of the transformer and the pressure required. Besides being a fast production method, it is very economical in upkeep of dies, as they are plain flat surfaces or faced with Elkonite inserts. In either case the life of the dies is very long.

The transformer capacity required for projection welding is approximately 50 per cent more for each projection than would be required under similar conditions for single spot welding.

There are projection welding machines in use making as many as 60 projection welds in a length of thirty-six inches at one time. These, of course, are very large machines with very large transformers. We build projection welding machines with transformer capacities up to 1200-KVA, and adjustable welding pressure up to 100,000 pounds.

All Welded Tanks with Capacities up to 475,000 Gallons

THE substantial progress being made in the fabrication of tanks by welding finds its latest example in the twelve all-welded tanks, of more than 2,000,000 gallons total capacity, constructed at Patchogue, Long Island, N. Y., by the Buffalo Tank Corp., for Patchogue Oil Terminal Company.

The advantages of welded over riveted construction for tanks utilized for storage of volatile liquids are clearly defined. In addition to the savings of welded over riveted construction there are very substantial savings in the maintenance costs. The "sweating" and leakage which frequently occur in riveted tanks are eliminated by welded constructions, which gives welded tanks a very decided superiority for oil and gasoline storage.

All of the tanks employ five rings. The two largest tanks, 50 feet in diameter by thirty feet high, are constructed with ¼-in. bottom; the lowest course is 5/16 inches thick, the next two ¼ in., and the remaining two courses and roof, 3/16

Spider Used for Rounding Tank Shell. It Later Serves as a Scaffold for Erecting Dome of Roof Which Has Six-Inch Pipe for a Center Support.

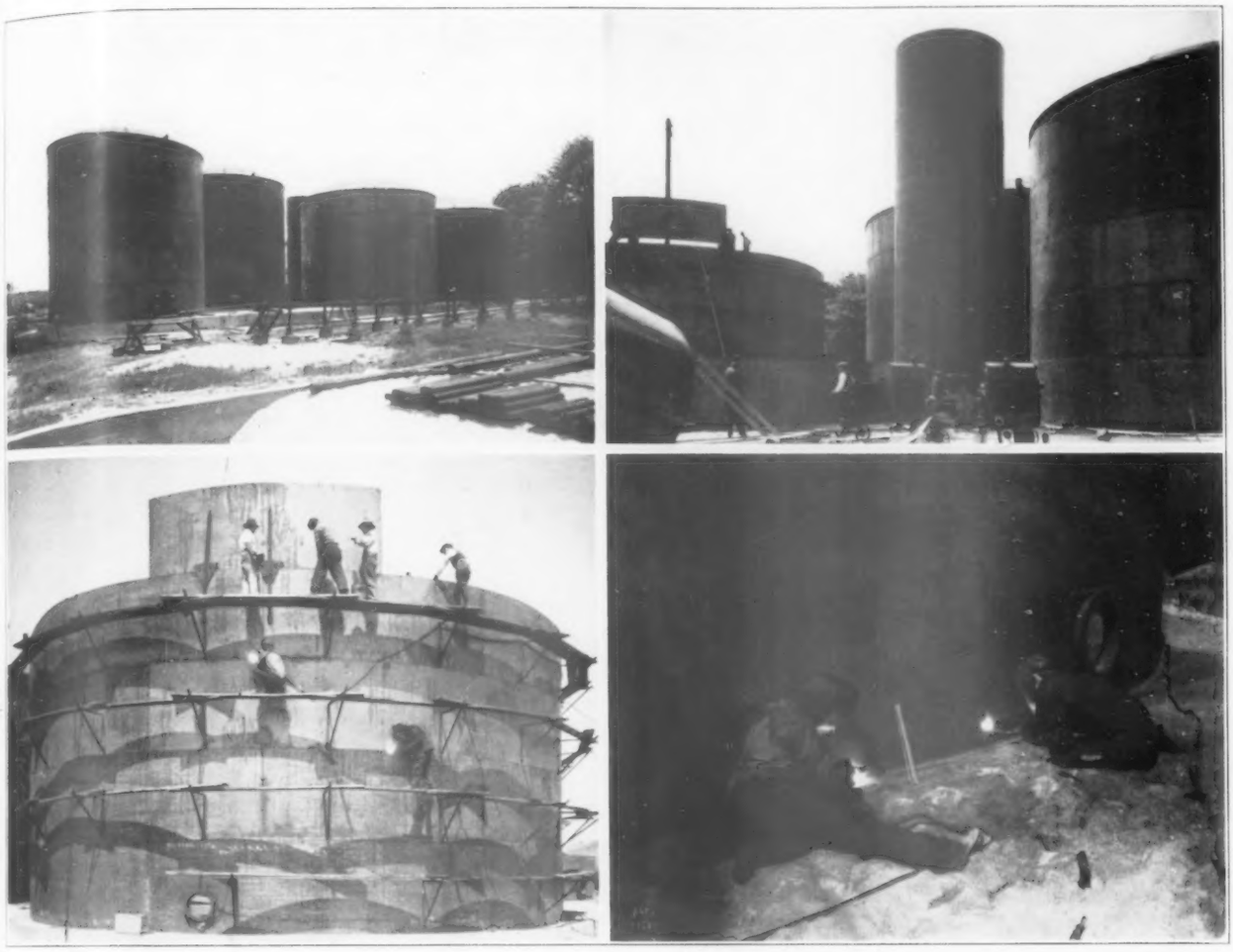


Figure 1. (Upper Left) Welded Tanks Showing Partially Erected Oil Truck Loading Rack in Foreground. Figure 2. (Upper Right) Plate About to Be Lifted into Position on Tank at Left. Small Tank was Shop Assembled and Shipped to Site. Figure 3. (Lower Left) How Plates Are Set in Position and Bolted. Later All Bolt Holes Are Welded Shut. Figure 4 (Lower Right) All Vertical Seams, without Exception, Are Welded Up.

inches. These largest size tanks weigh approximately 81,000 lbs. Capacity is approximately 475,000 gallons. Two tanks are 40 by 30 feet, two 30 by 30, and one is 25 by 30. The five additional tanks, size 10 ft. 6 in. by 35 ft. are shop fabricated; these were assembled at Buffalo, N. Y., without bolting of plates, by means of special jigs and shipped by rail to Patchogue, Long Island, and trucked one mile to site. Generally speaking, these are the largest size tanks it is entirely practical and feasible to ship for long distances.

The illustrations provide a good picture of construction methods. In Fig. 2, plate is shown immediately prior to being placed into position. The first ring of a 40 ft. by 30 ft. tank is also shown in this illustration. The method of setting plates in position, and the bolting up of the plates is shown in Fig. 3. All of the bolts shown are removed after seams are welded, and the bolt holes are then welded. Upon testing of the tanks by completely filling with water, it was reported that no leaks were discovered. The field constructed tanks will not be painted until approximately six months following erection, so as to permit mill scale to rust and loosen up; wire brushing will precede the work of painting. Approximately 4,000 pounds of welding wire were used in the construction of the tanks, and approximately 600 hours were required for welding with two machines.

A. S. M. E. Boiler Code Receives Final Approval

Announcement has been made that the new revisions of the Boiler Code allowing the use of fusion welding in the construction of pressure vessels and power boilers was adopted by the Boiler Code Committee on June 27th and approved by the Executive Committee on July 7th. The code as finally approved is practically the same as the form which was published in Mechanical Engineering for June, 1931. The wording has been changed so that different kinds of welding are not classified as A., B. and C., but the separation of pressure vessels into classes 1, 2 and 3, is retained. Before its final adoption there were two points in the proposed specifications about which there was considerable argument. One of these was the subject of requiring the X-ray test for class 1 vessel, and the other was the subject of stress relieving. The X-ray test requirement has been retained, but some opportunity has been left for substituting other non-destructive means of examination in the future. On the subject of stress relieving, the code makes the requirement that this shall be done by heat treatment.

S. A. E. Will Participate in National Metal Congress

The Society of Automotive Engineers has arranged to meet in Boston the week of September 21 as part of the National Metal Congress and Exposition. R. S. Burnett, manager of standards of the S.A.E., has arranged a session dealing with problems of the automobile industry from the standpoints of metallurgy, production and cost. This session will be held Wednesday morning, September 23, at the Hotel Statler.

Structural Arc Welding Progress*

The Erection of a Long List of Welded Structures Is Evolving a Proper Procedure for Wider Acceptance of This Class of Work

By A. F. Davis†

A YEAR or so ago the Board of Directors of the Irving Trust Company of New York sent out engraved notes of apology to some five hundred of their neighbors, asking their indulgence "during the unavoidably noisy weeks that lie just ahead" while the steel frame of their new building was being erected. Some time after this, the Union Trust Company of Cleveland added part of another floor to their twenty odd story building, but they sent no apologies for noise—they welded.

When Structural Arc Welding is mentioned one automatically thinks of buildings which are erected in the field, either wholly or in part, by arc welding. However, it seems to the writer that there are two distinct phases of the subject, namely:

1. Field erection or construction.
2. Shop welding of structural members and details such as trusses, details, etc., which may be used in buildings erected or constructed in other ways than by welding.

Figure 1. Silhouetted Against the Sky, This Arc Welder Makes a Twentieth Story Addition.

Each has its distinct problems and it is our intention to more or less treat the subject in this way.

In order to get a picture of the present status of structural arc welding it seems desirable to give a brief history of what has transpired in its application to the erection of buildings, then to point out a few of the questions and what is being and has been done to solve them.

*Extract from a paper presented at the Western Metal Congress, Feb. 16-20, 1931, San Francisco, Calif.

†Vice-president, The Lincoln Electric Co., Cleveland, Ohio.

Milestones of Progress

So far as the writer knows, the first structure in this country in which arc welding was used in an important part was the old plant of the Lincoln Electric Company in 1916.

A four-story concrete block building had its floors seriously overloaded and the blocks began to crumble. A complete welded steel structure was built into the existing structure without disturbance to the factory operations.

In the Province of Ontario, a highway bridge of three spans, 672 ft. over-all, carrying the heavy traffic into the city of Toronto, was constructed in 1923 of arc welded steel and concrete. The design of the bridge was unique. All of the steel work was made up of round bars. The steel carried the entire load, the concrete serving solely as a protection for the steel. Before this bridge was built the design was severely criticized by engineers not familiar with the possibilities of arc welding. However the designer knew what could be accomplished. The bridge was built and it met all required tests, and it was built at a cost far below that of riveted construction.

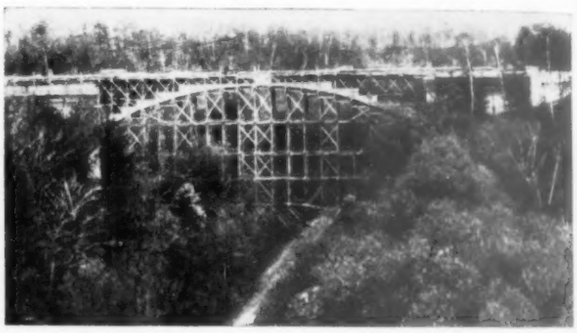


Figure 2. Arc Welded Bridge During Construction in Toronto, Canada.

It was only shortly after this that in Detroit the steel framework of a 12-story addition to the Peoples Outfitting Company building was arc welded, where the floor girders were framed into the columns, at a considerable saving of both money and inconvenience.

In the early part of 1925 the writer was approached by the late Mr. Richard Storm of the Morgan Engineering Company of Alliance, Ohio, as to the advisability of completely welding the Peerless Auto Sales Company Building of Canton, Ohio.

Although originally designed as a riveted job, the contract awarded on a competitive basis and the shop details made for riveted construction, it was decided to weld the job throughout.

At approximately the same time the same company constructed a large crane runway in which were used 16 A frames and 14 large built-up girders, all fabricated by welding. A great deal of credit is due Mr. Storm for his foresight and ability in pioneering welding.

In November of 1926 there was erected by the Westinghouse Electric & Manufacturing Company at Sharon, Pa., the then largest all-welded steel frame building. This was a five-story warehouse which utilized 790 tons of steel.

Shortly after this a number of buildings were erected by this process, one of the most interesting of which was the Upper Carnegie Building, erected by the Austin Company in Cleveland. This was a four-story building, 60 ft. by 119 ft., which, while not large, embodied several unique features, among which was the use of continuous beams which were welded in the middle of the building and the use of columns broken at each floor.

Since this time there have in all been a considerable number of buildings fabricated by welding. Among them are:

The Factory Building at West Philadelphia. Works of the General Electric Company, consisting of approximately 1,000 tons of steel.

The Homestead Hotel Building at Hot Springs, Va., fabricated and erected by the American Bridge Company.

The power plant adjoining the Chalfont and Hadden hotels at Atlantic City, N. J., fabricated and erected by the Bethlehem Steel Company.

The 14-story, 1400-ton office building of the Edison Electric Illuminating Company of Boston, Mass.

The 3000-ton shop riveted, field welded building of the Southern California Edison Company at Los Angeles, Cal.

The 19-story building of the Dallas Light and Power Company at Dallas, Tex., erected by the Mosher Steel Company.

The Dallas Gas building, Dallas, Tex., designed for 22 stories, of which 14 stories are being erected at present.

Recent statistics collected by the American Welding Society show that welding has taken a prominent part in over one hundred buildings or structures, with an estimated tonnage of over 100,000. Doubtless there are many more, and now almost daily we hear of new welded projects. Municipal Building Codes have been one of the factors that has retarded the more rapid progress of structural welding, but this bar is being gradually removed. More and more cities are adopting, either wholly or in part, the welding code suggested by the American Welding Society. Today the known number of cities that have changed their code is probably at least one hundred.

Dependability

The reliability of welding is often questioned, particularly by those who are not familiar with the process. However, it is interesting to note that out of the large number of welded buildings, so far as it is known, there has not been a single failure, and this in spite of some very severe tests. As an example we would like to cite several cases which have come to the writer's attention. There have been in recent years quite a number of packing houses erected in Florida of steel arch construction by the Arch Construction Company of Orlando, Fla., the arches being constructed entirely by arc welding. The framework of one of these buildings was almost entirely finished and a good share of the masonry when a hurricane came along and approached the building from the rear, blowing in the rear wall—going through the entire length of the structure and blowing out the front wall. The bar joists had been welded in place on the supporting beams by short fillet welds along the edges of bearing plates at the ends of the joist, and even though the entire wall fell on these bar joists, causing them to bend almost to the floor slab, the welds held the joists to the beams, causing even the beams and the supporting columns to become badly distorted. In order to clear the wreckage it was necessary to cut the bar joist from the beams by gas, the welds still being in practically perfect condition.

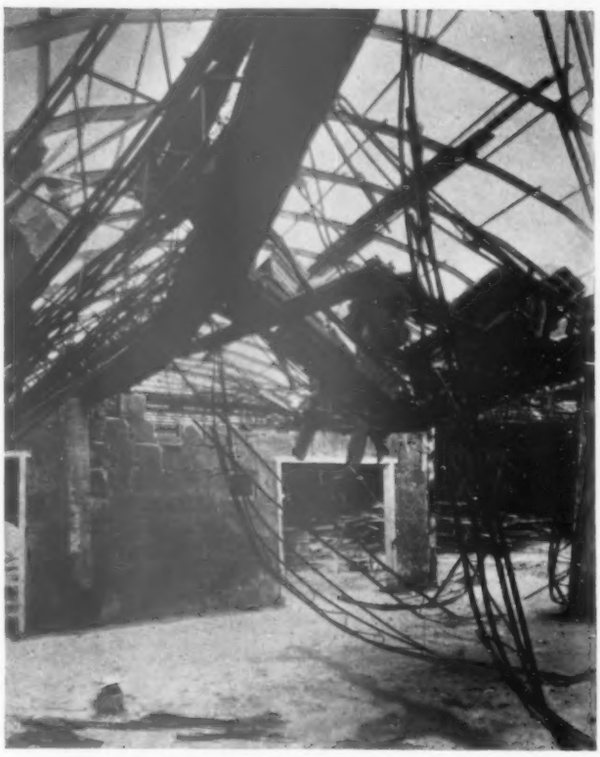


Figure 3. A Hurricane Hit This Building with the Results Shown. However, Every Weld Held.

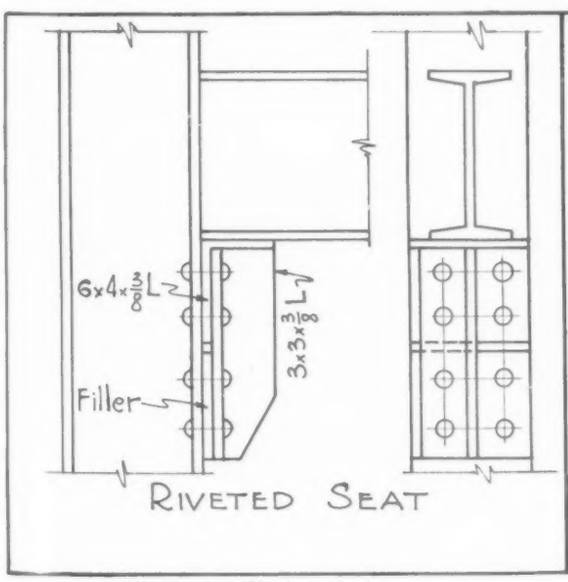


Figure 4. Riveted Beam Seat for 45,000 Pound Load.

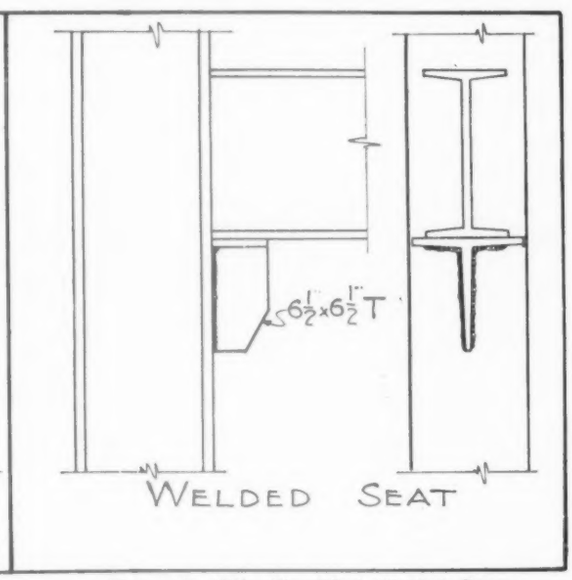


Figure 5. This Simplified Welded Beam Seat is the Equivalent of Figure 4.

Recently a cyclone struck the Houston (Tex.) airport, causing a damage of approximately $50,000 to planes and a masonry hangar, but passing over three arc welded steel hangars alongside, without even causing a dollar's damage.

There are numerous other examples which show that welded structures which, when done with proper procedure and inspection, are perfectly reliable.

Uniformity

Another question frequently heard is as to the uniformity of welds. We think it safe to say that with proper procedure and inspection a uniformity equal to that of any other mechanical type of joint will be secured. A year or so ago the

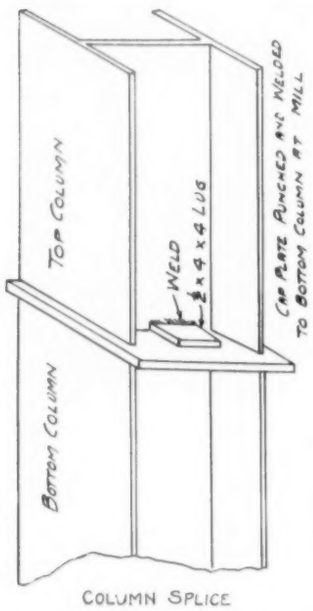


Figure 6. Column Splice Between Same or Different Size Columns.

Mill Welding Includes a Bolting Lug to Top Column and a Cap Plate to Bottom Column. Field Connection Would Be Bolted and a Horizontal Field Weld Would be Made Between Flange of Top Column and Cap Plate.

American Welding Society started a program of testing a large number of welded specimens in order to

1. Confirm or qualify previous results by the use of a larger number of specimens and a more uniform system of testing.
2. Supplement the scope of previous data by tests on additional forms of joint.
3. Determine what degree of uniformity in commercial welding may be expected.

The program covered 57 forms of joint in 191 sizes welded by the gas or the arc process. The specimens were of elemental type and embraced fillet welds of lap and tee form, end and edge butt welds, and special joints. Single and double lines of weld, normal, parallel and diagonal to direction of stress, continuous and intermittent, were specified.

Specimens were to be subjected to static tests for ultimate strength, yield point and ductility. These might be supplemented by dynamic and other special tests. The general aim was to proportion specimens so that they would fail in the joint and thus indicate unit weld strength, but for check purposes a few types were included that would probably fail in the base metal.

In order to determine what degree of uniformity might be expected in commercial practice, multiple specimens of each type and size were scheduled, whose preparation was distributed among about thirty-six representative fabricating shops throughout the United States and Canada. Operations were governed by uniform procedure and inspection regulations.

Quite a number of tests have been completed and those indicate a uniformity very closely checking the writer's previous statement in this respect.

We have previously mentioned proper procedure and inspection. By "Proper Procedure" we mean proper size, length and sequence of beads, proper electrodes, proper currents for the work, proper equipment and, lastly, proper preliminary tests of each operator to determine his fitness and ability to properly weld, and regular tests of the operator during the progress of the work.

Such tests have already been standardized by the American Welding Society for preparation of the welding specimens previously mentioned.

Inspection

We have referred also to proper inspection and a word in regard to this might be in order. Considerable progress has been made in devising methods for testing welds which are non-destructive, but so far as the writer knows none of these have yet been brought to the point where it might be said they are practical for the field. So visual inspection remains the most practical and is the one most used for field work. To the uninitiated, all welds may look alike, but to one experienced in arc welding the appearance of the finished bead will indicate to a remarkable degree the dependability and strength of the weld.

No doubt the completion of the testing program of the Welding Society will develop some very interesting data as to reliability, dependability and working strengths of welds. However, from a large number of welds which our company and others have made, the following working values for shear

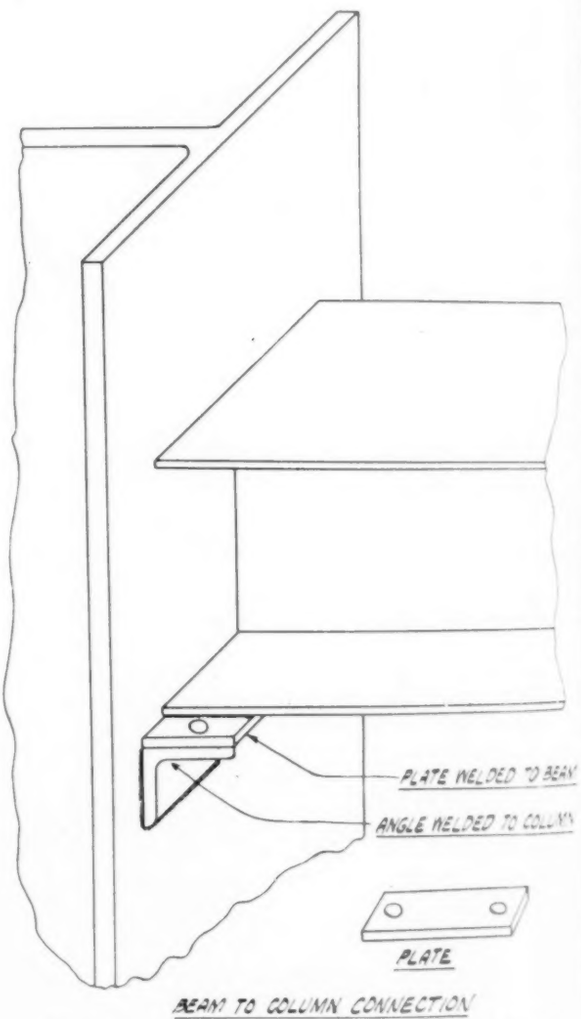


Figure 7. Beam (Narrower Than Column) to Column Connection.

Mill Welding Includes Flat Plate to Bottom Flange of Beam and an Angle to Column. Each is Drilled for Bolted Field Connection. A Horizontal Weld Across Beam Flanges and Vertical Along Web is Made in the Field if Required.

and tension have been found to be safe, practical and conservative:

3/16" Full Fillet Weld.....1,500 pounds per lineal inch
1/4" Full Fillet Weld.....2,000 pounds per lineal inch
5/16" Full Fillet Weld.....2,500 pounds per lineal inch
3/8" Full Fillet Weld.....3,000 pounds per lineal inch
1/2" Full Fillet Weld.....3,500 pounds per lineal inch

For welds in compression values 20 per cent above those given in the table may be used.

These values are based on the use of a good grade bare or lightly coated electrode.

Advantages

The question, however, which is probably heard most is: Why weld structures at all? The answers, as the writer sees it, are two:

1. Elimination of noise.
2. Possible economies.

Of course, there are many, many cases where the elimination of the noise of the riveting gun is most desirable at any cost, and recently public notice has been largely focused on this phase, or advantage, of structural welding; but it is the writer's belief that in the long run the widespread use of arc welding in structural work is going to depend on whether or not savings in dollars and cents can be made over the present methods used and it is a remarkable fact that so far there have been no savings, or at least very little, where structures have been entirely or largely fabricated and erected by welding.

However, that there is a saving in the amount of steel necessary is unquestionable. Due to the possible use of continuous beams, the stopping of columns at each floor, the elimination and reduction in number of angles, plates, etc., for connections, it is estimated on good authority a saving of steel of 15 to 20 per cent is possible.

Erection Economies

As an example of the latter saving, comparative designs of a riveted seat and a welded seat is shown.

Fig. 4 shows a familiar riveted connection—a beam seat designed for a load of 45,000 lb. It consists of a 6-in. by 4-in. by ½-in. seat angle, a ⅜-in. fillet, a 3-in. by 3-in. by ½-in. stiffener angle, 12 in. long, and 8¾-in. rivets. While Fig. 5 shows the corresponding arc-welded connection. It consists of a piece of 6½-in. by 6½-in. T, 3 in. long, and 18 in. of ⅜-in. fillet weld.

Similar examples are numerous.

These savings in steel have been largely wiped out in welded structures through difficulties in erection and other problems, such as too much welding due to extreme conservatism or caution of the designer, too much overhead or inaccessible welding, which is much slower than horizontal welding.

Difficulties or increased cost in erection came from the trouble in—

1. Holding or clamping members in place till they can be welded.
2. Plumbing or squaring the building, etc.

These difficulties can, of course, be overcome by using a few holes in the various members to permit bolting in place until the building can be plumbed and squared and welded permanently. This scheme has been used in a number of cases and costs obtained which compare favorably with riveting. One such case was an addition 60 ft. by 200 ft. to the factory building of our company. This scheme has numerous advantages and some disadvantages. It permits the work to proceed as in riveted construction, with which every erector or fabricator is familiar. Naturally any work with which one is familiar proceeds more rapidly than work with which one is unfamiliar. Its disadvantages lie in the fact that when used necessarily the members must be put through the fabricating shop, entailing an additional operation, and it is almost as cheap to punch several holes for riveting as it is one for such bolting.

It is therefore self-evident that considerable economy would arise if the advantage of bolting over clamping could be utilized, provided the structural members would not have to go through the fabricating shop, but go direct from mill to job.

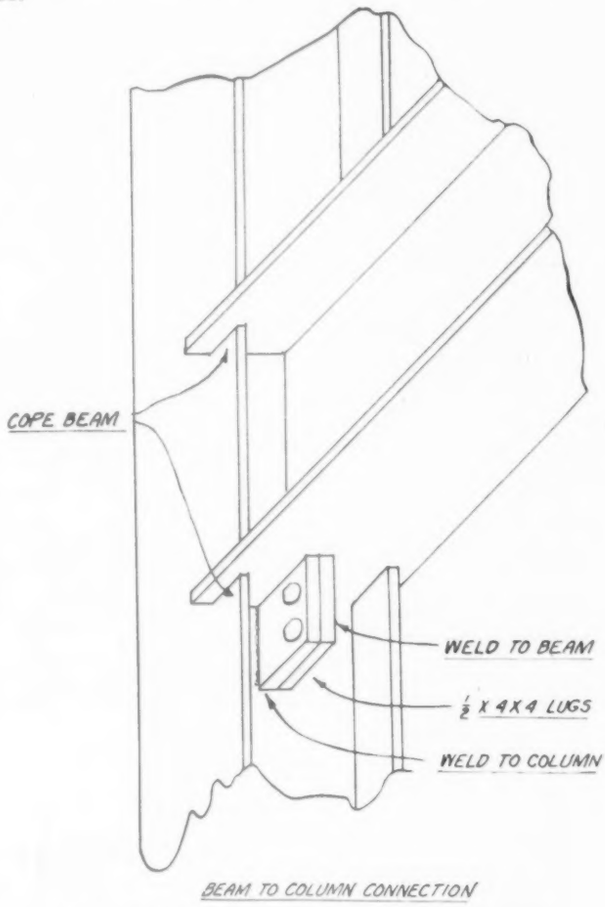


Figure 8. Beam (Wider Than Column) to Column Connection.

Beam is Coped to Clear Column Flanges and Field Bolting Lugs Welded to Beam and Column in the Mill. Field Welding Would Be Horizontal Across Beam Flanges and Vertical Along Web if Required.

Such a procedure was indicated as being possible in a paper presented to the American Welding Society some time ago by Mr. J. F. Lincoln. In substance, the plan is to utilize angles, lugs, etc., which have been punched and prepared in the fabricating shop and welded to the structural members on the job. To illustrate, several examples are given from this paper. Figs. 6, 7 and 8 are presented merely as suggestions rather than as typical details.

It is reasonable to expect that as time goes on and more and more buildings are erected by this process and experience gained that erection costs will come down so that the savings in steel will represent real savings in dollars.

However, we do wish to point out that today many economies are possible through welding and which do not interfere with erection by the usual methods. One of those is in wind bracing, and we wish to give our example taken from a series of Studies in Structural Welding, published by our company.

Wind Bracing

The prevailing style of riveted wind-bracing connection is the T-type. It consists of large T's formed from I-beam sections split in two lengthwise.

These large T's are riveted at the shop to the columns by a suitable number of rivets and field-riveted to the beam flanges, as shown in Fig. 9.

It is often possible to replace advantageously the riveted

T-type wind brace by the arc-welded knee-brace type shown in Fig. 10.

The knee braces are placed only at the intersection of the spandrel beams and wall columns, the floors being usually well able to transfer the lateral strains to the wall bracing systems.

It is to be observed that the use of the arc-welded knee-brace does not in any way change the usual erection procedure. The steel is raised, set, bolted up temporarily and plumbed in the ordinary fashion and then riveted together by means of the beam connection angles. Only when this has been done are the knee-braces placed and welded in position.

Evidently such a procedure is bound to speed up the job, not to delay it, since the riveters have less rivets to drive to obtain a well squared and plumb structure. The welder operators follow the riveters without interfering with them, and without getting in the way of the masons back of them.

Shop rivets cost about 4c each; field rivets 22c each and the large T's and fabricated connections 6c per lb., and welding, in the positions indicated, averages about $1.25 per lin. ft. On this basis, the cost of 120 riveted T-brace connections per floor is $1,334; that of the corresponding 40 riveted knee-braces $1,164. The cost of the 40 arc-welded knee-braces, including the riveted standard connection angles, is only $826 or one-third to one-fourth less than the cost of the riveted types of wind-bracing. In all cases the cost of the standard or other load carrying connection is figured in the total. On tall structures the saving effected by use of arc-welded wind-bracing represents an amount that cannot be ignored.

This brings us to a point previously mentioned—that in fabricating shop there are real economies possible, unhindered by external influences. It is, however, unfortunate that today many fabricating shops assess the same overhead to welded job as they do to riveted jobs, which is manifestly unfair since welding does not require anywhere near the same equipment, floor space, etc. If these shops would assess true overhead it is our opinion that welded work would show even greater economies than they do.

Economies in Shop Work

As an example of the economy possible in shop work we wish to show comparative designs of a riveted and welded

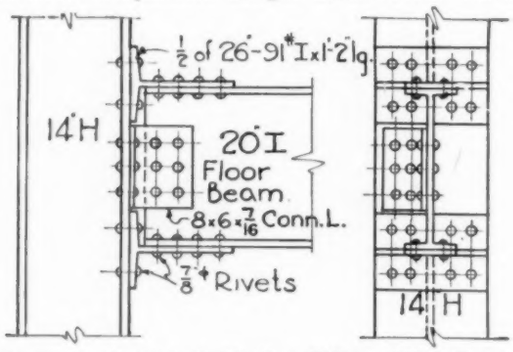


Figure 9. Method of Riveting T-Type Wind Brace.

plate girder. Let us take a girder of the following assumed requirements:

Girder span—40 feet.

Load (including allowance for girder weight) 146,000 lbs., concentrated at a center of span. Design of flanges to be made by the standard "Flange Area Method," allowing for web's resistance.

Spacing of stiffeners not to exceed depth of girder.

Bending moment to be resisted, 1,460,000 foot-lbs.

Shear to be resisted, 73,000 lbs.

Flange stresses not to exceed 18,000 lbs., per square inch on net section.

Though both girders are of exactly the same size and strength, the arc-welded girder weighs 2,329 lb. less than the riveted girder, a saving in weight of steel of 22 per cent. The riveted girder requires 890 lb. more steel in the main members, the web and the flanges, and 1,439 lb. more steel in the details, the stiffeners, fillers and rivets than the arc-welded girder. The saving of steel in the web of the arc-welded girder is made possible by use of a 46-in. plate instead of a 48-in. plate; the gross shear is not increased since the continuous welding of flanges to web make the effective web height the full height of the girder, as in a rolled beam.

The reduction in flange weight is due to there being no

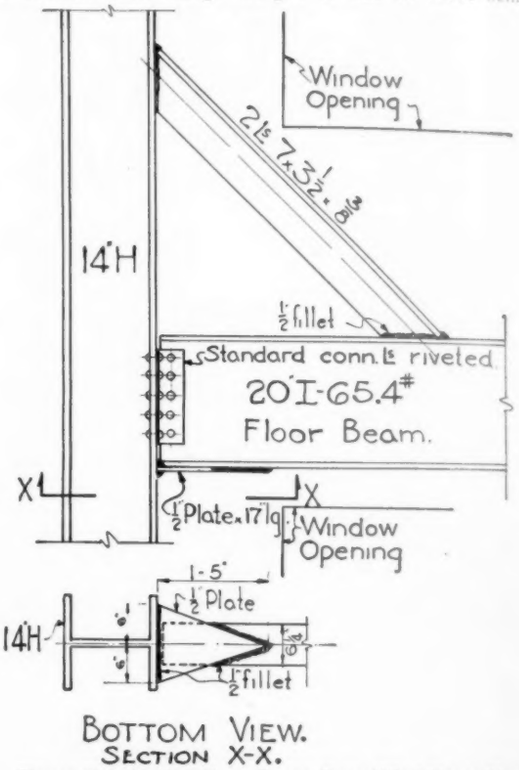


Figure 10. Welded Knee-Brace Type Wind Brace May Often Advantageously Replace the Riveted Type.

holes to be deducted from the gross section and also to the moment arm being a little longer in the welded than in the riveted girder.

The saving of weight in the details is due to the elimination of fillers, to the substitution of lighter stiffeners and to the advantage in weight of the weld metal over the rivets.

In the arc-welded girder there are one-half as many pieces to handle in fabricating as are required for the riveted girder. Thus arc welding also effects a material saving in labor.

The Austin Company, with headquarters at Cleveland, has fabricated by welding 136 flat type trusses 75 ft. long and 9 ft. deep in the center, also 63 parallel chord carrying trusses 40 ft. long and 8 ft. deep. These welded trusses are for the new factory building of the Simonds Saw & Steel Company of Fitchburg, Mass.

Their new plant, which is being both designed and constructed by the Austin Company, is the first industrial plant designed without windows and is also the first "CONTROLLED CONDITIONS" plant in industry.

Mr. Harry E. Stitt, chief engineer of the Austin Company, commented on these welded trusses as follows:

"They are stronger, stiffer and better trusses, also 15 to 20 per cent lighter than similar trusses of riveted construction would have been. They were constructed at a cost comparable to equivalent riveted type trusses."

There are literally thousands of other examples, far too many to attempt to enumerate in this paper. It is safe to say that this phase of structural welding will increase perhaps more rapidly than field work, but it is also safe to say that both phases of this work will proceed rapidly as the knowledge of welding spreads and as refinements of welding itself appear, and refinements and improvements of the process are appearing.

Hints for the Welder

WHEN YOU FIND a new way to do a hard job, or finish a particularly interesting weld, can you describe how the work was done? . . . . . Have you learned some little stunt every welder ought to know? . . . . . Write to us about these things . . . . . This department helps you welders to help each other. Write up your ideas any old way and just make rough pencil sketches . . . . We'll fix them up for publication.

Eighty-Six Foot Welded Flag Pole Completed in Four Days

The city of Morristown, N. J., has a brand new flag pole which was erected on July 4th of this year at the dedication of Fort Nonsense, where George Washington with his troops encamped for two winters during the Revolutionary War.

A wooden flag pole had been erected on this site, but it was found that it did not show over the trees. Just a few days before the time for the dedication, Leo Kappertz, President of the Morristown Welding & Radiator Company, was consulted on the subject of making up a longer pole of pipe, which the town was ready to supply. He promised to get the job done, and immediately got busy on it with one assistant. The result was the assembly of three-quarters of a ton of wrought iron pipe into one section 86 ft. tall.

Seven and one-half feet of the pole proper, together with four supporting, diagonally-set sections of the pipe, are hidden from view in the ground and set firmly in a concrete base. Seventy-eight feet project vertically from the ground level to a gilded eagle on top of the structure. A circular steel plate 20 in. in diameter is welded to the pole exactly at the surface of the concrete. Immediately below the eagle is a weather vane and underneath that a cluster of five 200-watt electric lights which illuminate the flag at night and provide a minor warning beacon to aviators. At night this light and the flag are easily visible for several miles.

The pole itself consists of a 16-ft. section of 8-in. pipe, two 14-ft. sections of 6-in. and 5-in. pipe, 12 ft. of 4-in. pipe, and two 10-ft. lengths of 3- and 2½-in. pipe respectively. This represents the height of the pole to the light cluster, and above that is a 5 ft. length of ⅞-in. solid steel which supports the eagle, the weather vane and flag halyards. The job was done by the electric arc process, using a gasoline engine driven, portable arc welder. The joints between the 8-in. pipe and the 6-in. pipe were made by cutting six 1-in. vees to a depth of 4 ft. in the 8-in. pipe and corresponding diminishing vees in the smaller pipe. These vees were welded together, thus shrinking 4 ft. of the pipe gradually down to the diameter of the next section. A butt weld was then made, and the danger of the sweating which may occur when a telescope joint is made was eliminated. Needless to say, it required first-class workmanship and a thorough knowledge of expansion and contraction to carry through the job in this manner and finish with a perfectly straight pole.

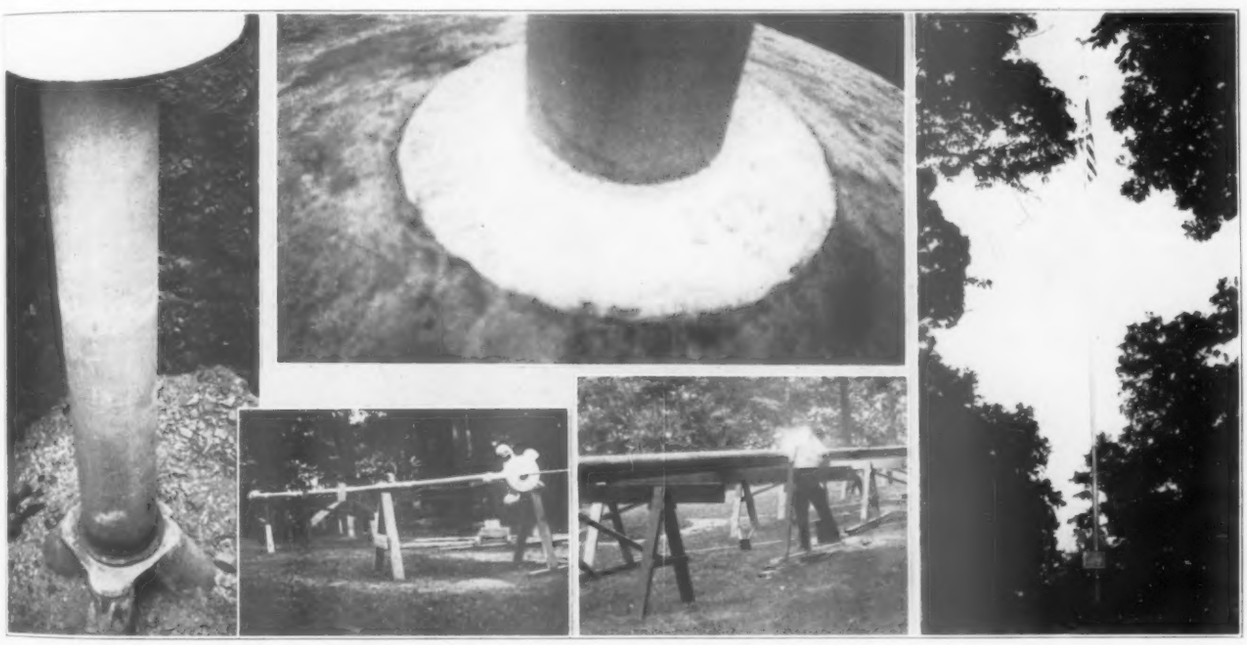


Figure 1. (Left) Four-Piece Pedestal Base Set in Concrete. Figure 2 (Top Center) Flange Shoulder Welded to Top of Pedestal. Figure 3 (Below, Left) Brake Drum Welded to Top of Pole to Protect Wiring from Weather. Figure 4. (Below, Right) The Pipe Lined Up on Horses for Welding. Figure 5. (Right) After the Dedication.

An interesting feature of the job is the foundation. This consisted of a four-piece pedestal made up of 4-ft. lengths of 6-in. pipe. These were set up diagonally, as shown in Figure 1, and welded together with angle iron braces as ties and 10-in. plates at each bottom end to prevent sinking. On top of the pedestal is a ½-in. plate welded with a 6-in. coupling to receive the pole while setting it. A flange shoulder is welded at the bottom of the pole, and this was welded to the top of the pedestal after the pole was plumb. This shoulder is shown

in Figure 2. The electric wiring is inside the pole and runs through a conduit which is welded to the pole, top and bottom. A brake drum from an automobile wheel is welded to the top of the pole as shown in Figure 3 to protect the wiring from the weather. Then as mentioned above, a ⅞-in. solid stem is welded on top to carry the weather vane and the eagle. The entire job was done on the summit of the hill and on very uneven ground. Other illustrations show how the pole was set up on wooden horses for welding and how it appeared when completed.

How Broken Studs Can Be Removed

Geo. A. Work, proprietor of the Ord Welding Shop, Ord, Neb., sends in the following suggestion for removing broken studs or bolts. "To remove studs which are broken flush with the face of the casting or part, place a common plate washer with a hole slightly smaller than the stud just over the stud, and using the hole for a target, build up a lug by welding on new metal, fusing the metal to both stud and washer. The heat that has been applied to the stud will cause it to upset itself, and when cooled, it will be loose in the hole and can be easily removed by gripping the lug or washer with pliers." This method of removing studs or bolts is known to a good many of the old-timers in the industry, and will undoubtedly come as a welcome suggestion to many new operators who have not thought of this application.

Unique Motor Boat Manifold Is All-Welded

The Harbor Welding Works, located in Wilmington, California, where a great deal of marine welding is done on ships and boats in the Los Angeles Harbor, recently completed a difficult and interesting piece of welding in the construction of an all-welded water-cooled manifold for a speed boat motor in the San Pedro Bay. A view of the completed job is shown by the accompanying photograph.

The total length of the manifold is about 39 inches. The view shows the intake in front with three points of intake. This pipe is of two-inch size. The shaping and distancing of these gas intakes from the carburetor was a very difficult proposition. Heating for bending and shaping for the proper division of distances for each intake was by means of the oxy-acetylene torch, and required much skill and care.

This Intricate Pipe Fabricating Job Was Easily Handled with the Welding Torch.

The outside pipe for the water jacket is of four-inch light weight pipe connected with three ½-inch water intakes and one 1-inch drain pipe. The inside pipe is of three-inch boiler tubing, affording a one-half-inch water jacket for water circulation.

Welding of the manifold was entirely by the oxy-acetylene process, and, when completed, proved highly efficient. Note the many welds and difficult angles necessary in the course of this important job of welding. The manifold was especially designed for a motor of 100 horsepower.

New Type Pressure Vessel Head Gives Increased Pressure Capacity

A marked improvement over methods commonly used in the past for closing the ends of pipe by the welded bull nose or orange peel method has been recently developed and proven by engineers of the Union Oil Company of California. This development has come about through the demands of the oil refining industry for tanks and other pressure vessels to withstand increased pressure; and as a result of much experimenting and testing, an increase of over fifteen hundred pounds pressure capacity was obtained in the new type of tanks shown in the accompanying photographs.

These tanks are being constructed to contain chlorine gas for use in oil refining, and are made of ten-inch seamless pipe with ⅜-in. walls. They are designed for a working pressure

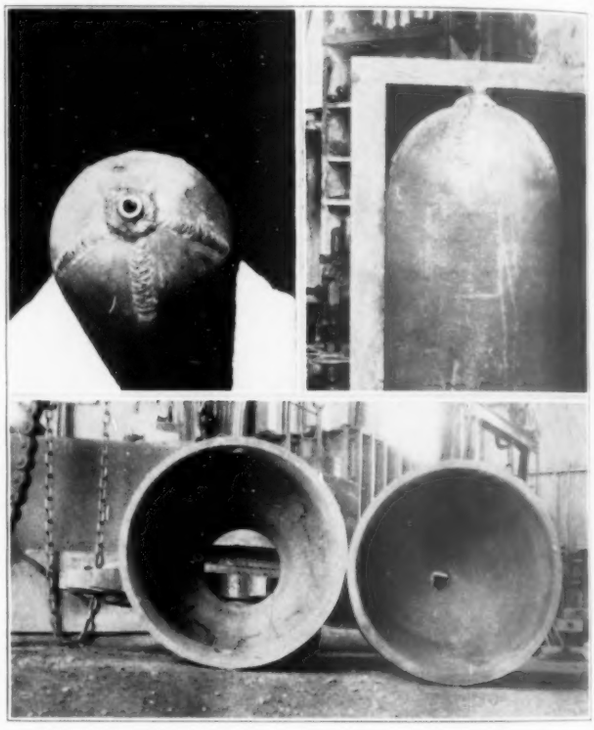


Figure 1. (Above Left) End View of Completed Head. Figure 2 (Above Right) Pipe Angles Away from Side Before Weld Starts. Figure 3 (Below) Typical Dies for Forming the Heads.

of 300 pounds per square inch and tested upon construction to 450 pounds pressure.

The feature which provides the added strength in this improved type of head, is in the swedging or pressure shaping under heat after cutting out the segments and before the welding operation is started. As noted in the picture (Fig. 1), there are five segments cut out to form the closing of the pipe head. In Fig. 2 it will be noted that the finished head angles from the straight edge of the pipe for approximately one and one-half inches from the end of the segment weld. This is clearly shown as can be seen by looking at the edge of the square which is used to illustrate this feature. This is accomplished by furnace heating to a cherry red the entire pipe end to be closed, and placing the end in a specially machined shaping die. A view of two of these dies (one for the top end and the other for the bottom end of the vessel), is shown in Fig. 3. Upon being placed in the die, the heated end of the pipe for shaping is then placed under the trip hammer and forged to the proper shape. Proper bending together of the segments is then done and the welding of the head is carried out in the usual manner.

Construction of these vessels calls for a fitting in one end of the tank. For the sake of added strength, the entire end of

the vessel is closed as the segments are welded together, and the cutting torch then used to cut the hole for the fitting, which is welded in with a strong, heavy bead, as shown in Fig. 1.

A test was recently made to determine the increased pressure capacity obtained in this new method of closing pipe ends over the usual orange peel head, the results of which were interesting and highly satisfactory. A tank constructed by the usual orange peel method commonly used in the past was put under pressure and failed at five thousand pounds. Next a tank designed and constructed under the improved method was hooked up and given all the pressure which the compressor was capable of giving, which was sixty-five hundred pounds. The vessel showed no signs of failing under this test.

This company has adopted the use of this method of closing pipe heads and for all of their pressure vessels requiring a working pressure of two hundred pounds and over, and the engineers are very enthusiastic in recommending this procedure to anyone using this type of pressure vessels. Specially made templets have been measured and made for proper cutting of the segments on the different size of pipe used for the different vessels required. This also required a great deal of figuring, in view of the fact that the segments are not cut back the full distance to where the angle from the straight edge of the pipe begins.

Construction of these tanks is under the supervision of G. W. Carl, foreman of the company welding department at the Santa Fe Springs machine shops.

Working Hints for Silver Brazing Monel Metal and Nickel

Because of certain advantages which silver solder joints have in connection with monel metal and nickel, the engineers of Handy & Harman, manufacturers of silver solders, and of the International Nickel Company, manufacturers of monel metal, have worked together on the development of a set of instructions covering the use of silver solders on these two metals. These instructions were recently published in a bulletin of the International Nickel Company, from which the following suggestions are abstracted:

The importance of working on clean materials is so great that if dirt and grease cannot be removed by mechanical means, chemicals should be used. It is also important to have a tight fit at the joint, because only a very thin film of silver solder is needed to produce a strong job. A hot, saturated solution of borax is recommended for flux. A slow preheating of the metal adjacent to the joint is also recommended. The bulletin states that it is not advisable to do silver soldering on nickel or monel metal at temperatures between 1450 and 1600 degrees, but that the joint should be made at temperatures below 1450 degrees Fahrenheit. The International Nickel Company recommends the use of a small, pointed flame of a small oxy-acetylene torch or a small oxy-hydrogen torch, concentrating the heat along the seam and keeping the flame slightly in motion in the direction of the seam. When this technique is used no preheating adjacent to the seam is necessary. The heat developed at the joint should be just sufficient to have the silver solder flow freely, the flux being viscous rather than fluid at this temperature, and being applied as a paste when used with this technique. A special silver solder called type RT, which melts at 1325 degrees has been developed for this work. It is stated that the oxy-acetylene torch is usually the best but that on account of its intense heat, the flame must be kept in motion. If the flux runs off the joint during the soldering, a small amount of boric acid can be added to the borax, which makes it thicker. Care should be used, however, not to add too much, because it has a tendency to raise the melting point of the flux. The work should be shielded to shut off strong light and drafts, and reasonable speed should be used. There are two difficulties which are apt to occur. One of these is pin holes which may be caused by too much or not enough heat, or by dirt, or oil or by improper fluxing. Another difficulty is balling up the solder, which usually indicates improper fluxing or overheating.

Building a Job Welding Business

By W. Irving Brockson

VI—Direct Mail Advertising

PART I

ONE of the most effective "tools" to use in building a job welding business is direct mail advertising.

The term "Direct Mail Advertising" is used in this sense to mean advertising which is sent to definite and selected persons or firms which are users or possible users of job welding service. It is contrasted with advertising which is put in newspapers and magazines and which may be seen by anyone who reads the periodical—whether he is a possible customer or not. The word "mail," of course, is included in the above term to mean the material—cards, printed letters, booklets, folders, etc.—which is sent through the mail, as opposed to being distributed by messenger from door to door, or by some other method. To be an effective "tool," direct mail advertising must be properly planned, printed, mailed and followed up, and it is the purpose of this article to make some suggestions which may be helpful in these various steps.

The Purpose of Direct Mail Advertising

Some business men have a very hazy idea of what direct mail advertising will do as a builder of sales; others expect it to do the impossible. Consequently, it is well to have in mind at the very outset just what objectives you may reasonably hope to reach through this medium.

Letting People Know About Your Shop

If you are just starting in business, you can announce to a selected list of prospects the establishment of your shop and explain the kind of work you do. By sending out subsequent mailings at regular intervals, e.g., once a month or once in six weeks, you will keep your prospects reminded of your shop—"keep your name before them"—and cause a large percentage of them to think of you when they need welding.

Build Good Will

If your direct mail advertising is well handled and done with a fair degree of regularity, not spasmodically, the prospects will, perhaps without realizing it, get the impression that yours is a live, progressive concern, capable of turning out first class work. If your direct mail is sent to companies that have patronized you, it will help to remind these customers of the work you performed for them, and if you did a good job, tend to bring repeat business. All this is a part of that very important asset called "Good Will," defined in substance by the United States Supreme Court as the tendency of the buyer to return to the source where he has been well served.

Educate Your Prospects

People in general have poor memories, particularly in regard to the business of others. Even though you may have done work for a certain firm, the individuals in that organization who have the authority to give you an order are likely not to be familiar with all the kinds of work you can do. For example, a firm for whom you have done gas welding job may not know you do electric welding; one for whom you have welded may not know you can do cutting. If you operate a machine shop, your welding customers are likely not to know about your machine shop facilities. Hundreds, perhaps thousands of firms which have had welding of one kind or another done, do not realize the wide scope of jobs to which welding can be successfully put.

By means of direct mail advertising, you can gradually inform your prospects of the full scope of your services and the many uses of welding. For example, one piece of advertising you send out can list in easily readable form, all the classes of welding and cutting you do, as well as your machining facilities, if you have them. Your letterhead can list these at the top or at the side. Then, you can send one mailing featuring gas welding, another arc welding, a third automatic welding, etc. Moreover, one circular or letter might dwell on the success you have had welding tanks, another with repairing broken gears, a third with reclaiming auto parts, etc. By keeping up such a program as this, sending your customers and prospects letters or other pieces of direct mail at intervals, you are bound to EDUCATE MOST OF THEM as to the complete scope of your services.

Getting Inquiries

One of the most important things direct mail advertising will do is to bring inquiries, develop leads which you can follow up by personal calls, locate many of the people who are interested in a greater or less degree in your layout. These are the people upon whom you should concentrate your efforts and try to develop into customers.

You should strive to make it as easy as possible for your prospects to reply. To do this you can (1) enclose a reply card or envelope showing your return address; (2) offer to send the results of certain tests which have been made by some authority on welding; or (3) offer him a booklet on some timely subject, a supply of which you may very readily obtain from one of your sources of supply. Use your ingenuity and do anything within reason to get him to answer your circular, because with an answer at hand, you have a logical reason to make a call; you have something to talk about that he is interested in and you have taken the first step towards making a sale.

Mail Orders Not Likely

Through direct mail advertising, you cannot expect many firms to telephone or write letters asking you to bring over your outfit and weld up a certain job. This will happen only in rare cases, and if you start out to "let Uncle Sam do your advertising" with the idea of getting immediate orders, you will be disappointed. But you can expect to acquaint selected persons and firms with your shop, build good will, educate prospects to all the services you can perform and to the wide use of welding, and as a result, either get inquiries which you can by personal contact develop into orders or pave the way for successful personal calls on prospects who do not reply.

"Exploded" Objections to Direct Mail

Before going further, it is well to comment on some objections which one occasionally hears from people insufficiently informed on direct mail advertising.

Did you ever hear the comment "That stuff is no good—it only goes in the waste basket"? Most certainly, a large percentage of it does and always will go into the waste basket. But if it has been properly managed by its sender, it will do a world of good before it gets to the 'bone yard." People have seen it, read parts of it and received impressions from it. They have noticed your name and have at least got the idea that you do welding. One circular may make but a very slight impression on the prospect; he may not even remember he saw it, but the sum total of impressions made by a series of four, six or twelve mailings is bound to "register" with a high percentage of prospects. It's the same old story of the continual dropping of water wearing a hole into a stone.

And, besides, the planning of direct mail is all done on the basis that only a few of the prospects need reply in order for the project to pay for itself. Hundreds of very profitable campaigns bring returns from only two percent or less of their prospects.

Of course, there is waste in mail advertising, just as there is waste in the way drug stores, grocery stores, barber shops and other establishments run their business. But with the proper selection of the mailing list in the first place, i.e. by choosing the firms which have a logical use for job welding service, by getting the man or men in the company who have the "say" in placing job welding business, by sending them carefully planned circulars which talk business in their language, and keeping it up consistently, you are bound to get results.

"It Costs Too Much"

Another common objection presented by people who don't know their direct advertising "onions" is, "It costs too much." Do you know that some of the most successful circular campaigns have consisted of Government postal cards which cost only one cent for the card and the mailing and not more than another cent for the printing? What could be "cheaper" than that? Moreover, under the proper conditions, elaborate, illustrated folders in two and three colors can be printed and mailed for a cost of 5 cents each.

Now, just do a little "figgerin'." Suppose you have a list of 250 prospects, and you send them a mailing that costs 5 cents per name. You've spent $12.50. Now if you only develop one customer from that effort, the chances are that the first or repeat orders will more than bring your money back. Besides, if your "postal publicity" is properly executed in all respects, and if you follow through with good selling tactics, you should get more than one customer from such a program. It is quite true that millions of dollars are spent on direct mail advertising in the United States every year and that some firms make mailings of thousands of pieces every month. But mail advertising is likewise the willing servant and the effective tool of the concern that only has a few hundred prospects to reach. It is very flexible and adaptable and can be made to fit almost any kind and size of business.

Fatigue Test Leads to Interesting Conclusion

In a paper entitled, "Fatigue Test of Weld Metal," prepared by R. E. Peterson and C. H. Jennings of the Research Laboratories of the Westinghouse Electric & Mfg. Co., for presentation at the 34th annual meeting of the American Society for Testing Materials, which was held in Chicago in June of this year, there is given some interesting fatigue test data on weld metal proper, covering the effects of machining, annealing and peening. A particular feature of this investigation is the development of a rough weld metal fatigue test specimen. The conclusions are described as applying to 1 inch diameter weld metal specimens, hand welded, and are as follows: The direction of deposition of weld metal does not have a large effect on fatigue strength. Rough (not machined) weld metal has a higher endurance limit than machined and polished weld metal. Annealing at 1000° F. does not greatly change the fatigue strength of roughweld metal. Annealing at 1700° F. results in a coarser grain structure and a lower fatigue strength. Peening increases the fatigue strength of roughweld metal. Peening the outer layer only is as effective as peening each layer successively. The author states that tests on size effect which are in progress show higher endurance limits for smaller weld specimens and lower endurance limits for larger weld specimens.

Reducing Battledeck Floor Costs Discussed in Cleveland

Methods of further reducing the cost of welded battledeck floors were demonstrated to a group of engineers and architects at a meeting held in the warehouse of the Carnegie Steel Company in Cleveland on July 24th, under the joint auspices of the American Institute of Steel Construction, the Lincoln Electric Company, and the Carnegie Steel Company. One of the methods suggested was the use of plates 4 feet wide instead of 2 feet wide. It was also suggsted that it will be possible with the use of a new automatic carbon arc welding machine which the Lincoln Company is developing to weld the plates to the I-beams without punching holes. It is claimed that the welding time would be reduced about two-thirds, with the additional advantage of dispensing with the hole punching operations. A floor panel 8x8 feet was constructed during the demonstration, using two 4x8 feet plates which were welded to light I-beams spaced on 2-foot centers.

Processes Demonstrated for Waukegan Welding Club

At a meeting of the Waukegan Welding Club, which was held at the Aviation Mechanics School, Great Lakes, Ill., on Wednesday evening, August 5th, several interesting demonstrations of processes were made. Mr. Walters of Jos. T. Ryerson & Sons demonstrated the metallic arc welding of Allegheny metal, using a Wilson welder, and Mr. Van Dyke, also of Jos. T. Ryerson & Sons, gave a talk on the subject of stainless steels—how to fabricate them and how to weld them. Mr. O'Connor and Mr. Brandtburg of the Kenosha, Wis., plant of the American Brass Company, gave a demonstration of welding extruded brass so as to match the color, and also demonstrated the welding of cast iron with Tobin bronze. Mr. F. T. Pahre of the Warner Engineering Company, Pomona, Cal., demonstrated the use of the Weco-Weld machine in the welding of aluminum, brass and bronze and brazing of galvanized steel. Mr. W. A. Slack, President of the Torchweld Equipment Co., Chicago, gave an interesting talk on the value of association work and the benefits derived from keeping up-to-date on all practical and technical developments in the welding industry.

New York Contractors Adopt Trade Practice Rules

At a meeting of the Welding Contractors Association of New York, which was held Wednesday evening, August 5th, the Association adopted a comprehensive set of Trade Practice Rules covering the subjects of bidding, relations with competitors, and competitive prices. Included in these rules is a clause to the effect that where there are no governmental laws, rules or regulations as to welding practice, the regulations as laid down in the American Welding Society code shall govern. The meeting was held in Room 600 of the Graybar Building, and in addition to the business program, there were an interesting series of papers read. Gilbert D. Fish, Consulting Engineer, talked on the "Prospects of the Welding Contractor in Steel Construction." J. E. Bowman of Pittsburgh, talked on the "Arc Welding of Aluminum." C. E. Birch of New York talked on "Eye and Head Protection for Welders." It is reported that the attendance of the August meeting was in excess of the capacity of the meeting room and that a lively interest was shown in the activities of the Association as well as the subjects which were discussed by the speakers.

Fine Monel Metal Gauze Welded with Atomic Hydrogen

The accompanying photograph shows an interesting example of the nicety with which very fine materials can be welded by the atomic hydrogen method. The sample is an 80-mesh screen gauze woven of No. 36 gauge monel metal wire, and the weld was made in the Chicago service shop of the General Electric Company.

Atomic Hydrogen Weld in Fine Gauze Wire.

The weld, of the edge type, was made by clamping the two pieces of gauze between two pieces of steel about $\frac{1}{8}$"x1", leaving the edge of the gauze extending out about $\frac{3}{32}$". A 21-ampere current was used with $\frac{1}{16}$" diameter tungsten electrodes.

It was found that, when the metal started to flow, the best results could be secured by holding the arc a short distance away from the weld so that the metal gave the appearance of a half moon. It was also necessary to move as fast as possible when welding in order to prevent burning the material and at the same time to hold a steady arc.

After the weld had been completed the clamps were removed and the gauze flattened out.

Lorn Campbell, Jr., on European Trip

Lorn Campbell, Jr., President of the Harris Calorific Co., Cleveland, Ohio, sailed from New York on the Steamship Paris of the French Line on August 15th for Plymouth, England, in which country he is expected to remain for a couple of weeks. After that, probably with the idea of cooling off a little, he plans to start north and will spend some time in Norway and Sweden. Early in the fall Mr. Campbell states he will work his way south through Russia, Germany, Roumania, France and Switzerland, and finally down to Italy. It is his present plan to make the return from some Italian point, probably also touching at Algiers and Gibraltar. The proposed trip is intended to last for about three months, and we are told that this is strictly a business trip.

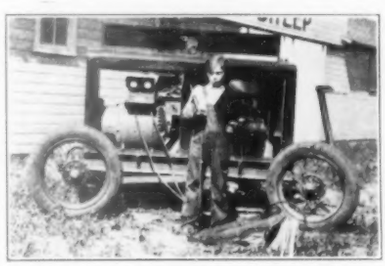
Hunt Laboratories Have X-Ray Installation

The Robert W. Hunt Company, Chicago, has recently added to its engineering laboratory a special room for making X-ray examinations of engineering materials. This room is equipped with a Coolidge tube operating at 200,000 volts. An interesting four page bulletin has been prepared which gives a description of this service together with illustrations and discussions of many typical cases in which X-ray investigations can be used in industrial work.

Here's the World's Youngest Arc Welder

Welders who attended the recent convention of Iowa Blacksmiths and Ironworkers at Spencer, Iowa, nominated a new name for entry in the "Welders' Hall of Fame." This new candidate is Master Raymond Joyner of Danbury, Iowa, who is believed to be the world's youngest master arc welder.

Raymond is twelve years old and is in the sixth grade at school. He has been arc welding for about two years. After school, on Saturdays and during summer vacation, Raymond works as a welder in his father's shop, and Mr. Joyner says that this is because the boy likes to weld and finds it more interesting than playing games. Frequently, Raymond has turned in several dollars' worth of work a day, and at no time have any of the jobs which he has done come back to the shop on account of dissatisfaction. It is stated that if there



The World's Youngest.

is any question as to the proper manner of handling a particular job, the youngster usually has a suggestion to make and his suggestions are considered just as seriously as those made by other welders in the shop.

The accompanying photograph, which was taken during the Iowa Blacksmiths Convention, by E. C. Caluwaert of the Northwestern Mfg. Co., shows Raymond welding with a gasoline engine driven Hansen arc welder.

Westinghouse Building Largest Welded Steel Condenser

The largest welded steel condenser ever manufactured is now being built by the Westinghouse Electric and Manufacturing Company at its South Philadelphia Works for Public Service Electric and Gas Company, of New Jersey. This is a 65,000 square foot condenser of the single pass, radial flow, welded steel plate construction and will serve a 75,000 kilowatt, single cylinder Westinghouse turbine generating unit. This order marks a decided departure in condenser manufacturing, utilizing the principle of welding in a new field.

Portland Section A. W. S. Elects New Officers

At the annual meeting of the American Welding Society, Portland section, officers were elected and activities for the coming year discussed.

The new chairman will be Geo. C. Dierking, production manager Steel Tank & Pipe Co.; vice-chairman, F. V. Romig, chief engineer, Beall Pipe & Tank Co.; treasurer, Wm. P. Kellogg, district manager, Air Reduction Sales Co.; secretary, G. B. Herington, consulting engineer.

It was proposed that a joint meeting be held with the Oregon Building congress, the Professional Engineers of Oregon and the American Institute of Architects, Portland chapter, and possible other interested bodies, and bring before the assembled professional men the rather remarkable progress in craftsmanship and accomplishment in the improved engineering function which welding has assured.

One of the features promised at this proposed meeting is a special program which William P. Kellogg, treasurer of the section and district manager of the Air Reduction Sales Company, has rehearsed and developed. According to G. B. Herington, secretary of the section, this meeting will, no doubt, be held in the early fall, and slides and papers on the progress of heavy pressure welding will be made available, together with the latest operation of structural welding.

"The Welding society and others working together have developed quite thoroughly scientific means of judging the efficiency of welds and developing the physical qualities of individual welders' delivered work. The matter is thus reduced from a chance basis to not only known result by inspection, but known anticipated result by the physical test records of individual welders' operations," Herington continued.

Wisconsin Welding Conference in October

Notice has been received that a welding conference will be held under the auspices of the Department of Mechanical Engineering, the College of Engineering, and the University Extension Division of the University of Wisconsin, on October 8, 9, and 10. The conference will be held in the new Mechanical-Engineering Building of the College of Engineering. It will comprise lectures, demonstrations, exhibits and discussions. All inquiries concerning the conference should be sent to J. M. Dorrans, Mechanical Engineering Bldg., University of Wisconsin, Madison, Wis.

Bulletin Tells How to Design Pipe Lines for Pressure

A four page bulletin has recently been issued by the American Rolling Mill Company, Middletown, Ohio, on the subject of "Designing Pipe Lines for Pressure." On the inside pages of the bulletin is a well arranged discussion which tells how to classify pipe lines under 24 inches in diameter, together wth a graph showing the relation between pressure, diameter, and wall thickness of pipe.

Westinghouse Bulletin Describes New A-C Welder

A leaflet recently prepared by the Westinghouse Electric & Mfg. Company is devoted to a description of the new FlexArc A-C arc welder which has 100 ampere capacity, and weighs 280 lbs. The bulletin discusses in detail the field of application of this machine, gives a list of the distinctive features, describes the construction and provides a chart showing the approximate average power cost of welding at various welding current values.

New Ryerson Bulletin Includes Welding Rod & Equipment Data

Joseph T. Ryerson, Inc., Chicago, Ill. have recently issued a bulletin in which types of welding rod and equipment are illustrated and described. Extensive information on uses is also included. The first pages contain information on gas and electric welding rods. Under these two classifications, a variety of rods representing all types of welding are described. The structure, characteristics and purpose of each rod is explained. The second section is devoted to the subject of acetylene and electric welding equipment. Included in this section are equipments of all types from portable welders to complete railroad track welding outfits.

Page Distributing Aluminum Fence Booklet

One of the recent developments in the fence industry has been the adoption of aluminum for the manufacture of woven wire fences. It is meeting with widespread approval by the trade, due to the fact that it is non-corrodable and does not require periodic painting to keep it in perfect condition. A booklet entitled "Why Aluminum Fence" outlining the development of aluminum fence, has recently been issued and a copy can be secured from the Page Steel & Wire Company, Bridgeport, Conn.

New Oxygen Company Formed in Denver

The Denver Oxygen Company, located at 901 Navajo street, Denver, Colorado, started production in its new plant on July 8th. The president of the new company is S. R. Hord, who has been for many years engaged in the oxygen business in Texas, and he has associated with him C. C. Cabiness of Oklahoma City, and J. H. Allison of Wichita Falls, Texas, who have also been engaged in the oxygen business in Texas up until April of this year. The company has a forty-meter plant in Denver and is equipped to turn out 160 220-cu. ft. cylinders of oxygen every 24 hours. The illustration shows the first cylinder of oxygen from the new plant being delivered to the U. S. Welding Works of Denver, which is owned by Chas. Lofgren. Mr. Lofgren has been in the welding business in Denver for many years. Mr. Hord states that a complete line of welding supplies, including carbide, will be carried.

First Cylinder of Oxygen Off the Line of the Denver Oxygen Company Being Delivered to the U. S. Welding Works.

American Brass Co. Exhibit at Boston Show

The feature of The American Brass Company exhibit at the National Metal Exposition will be demonstrations of oxy-acetylene welding with Tobin Bronze rods. The American Brass Company will occupy space C-131 at this thirteenth annual exposition, to be held on Commonwealth Pier, Boston, September 21st to 25th.

Mr. Charles Gallo, a well known authority on bronze welding, will have charge of the welding demonstrations and will instruct visitors in the proper methods of oxy-acetylene welding with Tobin Bronze. In addition to the demonstrations, there will be displayed an excellent collection of cast iron pieces that have been repair welded with Tobin Bronze filler rods. Everdur Metal, a copper-silicon-manganese alloy, weldable by all methods, will be shown in sheet, wire, rod, tube and cast forms. There will also be a display of Everdur tanks constructed by automatic electric welding. W. Harold Dowd, Exhibit Manager, will be in charge.

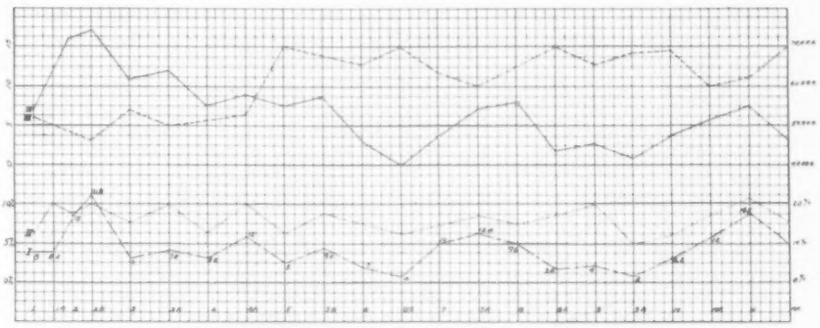
Experiments Show Effect of Nitrogen

A series of tests was recently made by Robert Notvest in his laboratory at 457 S. Arlington Ave., Indianapolis, Ind., to determine the influence of nitrogen upon the physical characteristics of fused metal. The specimens welded were 14 inches long, 3 inches wide at the ends and 2 inches wide for a distance of about 4 inches in the center of the strip. One-quarter inch boiler plate was used throughout. Several different types of electrode materials were used with results as shown in the following table:

Spec. No.	Welding Wire	Depth of Penetration	Nitrogen Content	Remarks
1	Heavy paste covered	0.06 to 0.10	0.03 to 0.06	Can be forged
2	Heavy paste covered	0.08 to 0.10	0.03 to 0.06	Can be forged
3	Asbestos covered	0.08 to 0.10	0.05 to 0.07	Can be forged
4	Asbestos covered	0.07 to 0.10	0.05 to 0.07	Can be forged
5	Bare	0.07 to 0.09	0.09 to 0.15	Cannot be forged
6	Bare		0.09 to 0.15	Cannot be forged
7	Bare		0.09 to 0.15	Cannot be forged
8	Dust covered	0.08 to 0.09	0.12 to 0.15	Cannot be forged
9	Bare	0.05 to 0.10	0.13 to 0.14	Cannot be forged
10	Dust covered	0.06 to 0.09	0.12 to 0.15	Cannot be forged
11	Bare	0.09 to 0.11	0.11 to 0.15	Cannot be forged

All specimens were welded by the same operator using 5/32 inch wire, 125 amperes, 20-21 volts across the arc on a Hansen arc welder. The depth of penetration was ascertained by having the operator lay a 2 inch bead on the test specimen, which, after rupture under tensile test, was sawed in half in the center of the bead and etched with HNO_3. The nitrogen content was determined by cutting out 200 grams of the fused metal for analysis. The conclusions reached by Mr. Notvest as a result of these experiments are: First, that nitrogen in fusion metal not in excess of 0.01 per cent slightly increases the yield point and ultimate strength with corresponding decreases in elongation. Second, oxygen in excess in the fusion metal causes red shortness, the criterion of this being whether the fusion metal can be forged or whether it can be bent or twisted without fracture when heated to cherry red. Third, heavy flux coated wire reduces the absorption of nitrogen by the fusion metal. Fourth, that all welds made with bare wire should be submitted to a forging test. The accompanying diagram shows graphically in the case of each specimen the depth of penetration, the nitrogen content, the ultimate strength in pounds per square inch and the percentage of elongation in 2 inches.

In commenting on these conclusions, Mr. Notvest points out that there are bound to be differences between electrodes of various manufacturers, not only on account of the difference in chemical composition, but also due to the methods used in drawing the wire. Another important influence is the chemical composition of the flux used; and, finally, the physical characteristics of the deposited slag—some of these slag deposits being easy to remove with a hammer and others being quite difficult.



LEGEND: I—Percent Elongation in Two Inches.
II—Depth of Penetration in 1/100 of One Percent.
III—Nitrogen Content in 1/100 of One Percent.
IV—Pounds Per Square Inch Ultimate Strength.

Armco Publishes Bulletin For Foremen and Plant Managers

The American Rolling Mill Company, Middleton, Ohio, publishes a bulletin for foremen each week. This bulletin was established for the purpose of making available the long experience of the Armco organization in safety and training, and to build institutional good will. Each bulletin is directed at the reduction of operation costs and points out common sense methods for the foreman or manager to use. It is stated that the material is drawn largely from experience in the Works Training Program of the company. We are advised that the American Rolling Mill Company is willing to add a limited number of foremen or executive readers to the list. Such requests should be addressed to H. W. Wright, Supervisor, Personnel Publications, American Rolling Mill Co., Middletown, Ohio.

New Lincoln Bulletin Gives Design Information

Two recent bulletins issued by the Lincoln Electric Co., Cleveland, Ohio, contain interesting and useful information on the design of welded structures. One of these is Plate 25 in the Lincoln series of Studies in Structural Arc Welding. The subject is "Arc-Welded Mill Buildings," and particular attention is given to the design of bar joists. The other bulletin is No. 21 of a series of Application Sheets. It is on the subject of "Design of Bases for Machinery."

Speed Reducer Housings of Welded Construction

Since the publication of a news item regarding the welded steel gears made by the Philadelphia Gear Works in a recent issue of *The Welding Engineer*, there has been received an additional bulletin which describes a complete line of steel speed reducer housings made by the same company, of welded rolled steel construction. It is pointed out that in steel mills or in other strenuous service where sudden impact with heavy objects would ordinarily crush a cast iron reducer casing, these indestructible steel housings protect the fine mechanisms which they contain from violence. An increase of from 75 per cent to 100 per cent in strength is claimed to be the result of using welded steel construction. The product illustrated above is a herring-bone gear speed reducer made for straight line drive.

Magnetic Testing Equipment Catalog Issued

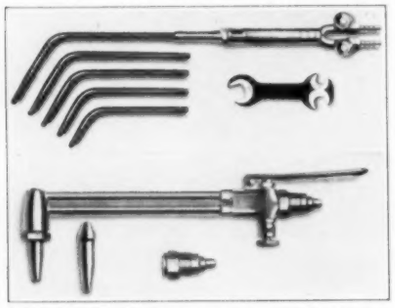
Catalog No. 3 recently issued by the Magnetic Analysis Corporation, 4244 Twelfth Street, Long Island City, N. Y., describes and illustrates several types of equipment for the inspection of materials by magnetic analysis. These equipments are supplied for either laboratory use or for factory and mill use. In the investigation of magnetic steels, they have been able to determine many important properties, and particularly to indicate the lack of uniformity in certain properties in a single piece.

Roebling Issues Complete Catalog of Welding Products

A new catalog of wire and wire products has recently been issued by John A. Roebling Sons Company, Trenton, N. J. This is a 280-page volume, pocket size, with flexible imitation leather cover. A large portion of the book is devoted to specifications and illustrations of various grades of wire rope, fittings and accessories, with instructions for ordering and handling these products. Another portion is descriptive of the Roebling line of welding wire for gas and electric welding and the Roebling line of flexible insulated cables for electric arc welding. Tables of wire gauges add to the value of this catalog as a hand book, and it is furnished with a comprehensive index.

New Purox Welding Torch and Cutting Attachment

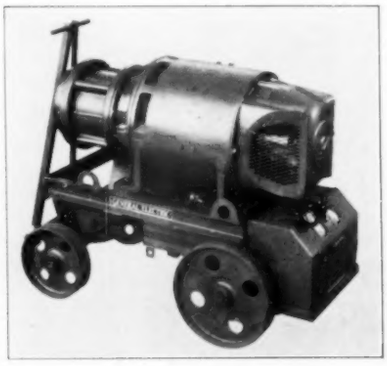
The Linde Air Products Company, New York, N. Y., has recently made two new additions to its line of Purox medium pressure apparatus for oxy-acetylene welding and cutting. The new Purox No. 11 Welding Torch, which supersedes the Purox No. 10 Torch, has a welding range extending from light sheet metal up to work as heavy as ½ in. plate. In spite of this wide range it is stated that the torch is very light in weight and has perfect balance. The tips are of one-piece, hard-drawn copper construction and are so designed that the head angle can be easily adjusted as desired by the user. Five tips are furnished as standard equipment. The Purox No. 21 Cutting Attachment designed for use with the Purox No. 11 Welding Torch. The manufacturers state that it will cut metal up to 2 in. in thickness. It weighs only 1½ pounds and is furnished with one and two piece Purox cutting tips. By means of this cutting attachment the welding torch can be easily and quickly converted into a cutting torch. An adaptor is also available which makes it possible to use the Purox No. 21 Cutting Attachment with the Purox No. 20 Welding Torch.



Purox No. 11 Welding Torch and Cutting Attachment.

New G-E Welding Sets Have Many Improvements

The General Electric Company announces a new line of single-operator welding sets in which are incorporated many improvements over past designs. This has been designated the WD-20 line as the types are numbered WD-21, 22, 23, 24 and 26, covering the 100-, 200-, 300-, 400- and 600-ampere ratings respectively. It includes both portable and stationary sets, the basic form being stationary with but a slight change needed to make it portable. Types include those for operation on either alternating or direct current at all standard voltages and, in the case of alternating current, standard frequencies and 2 and 3 phase Gasoline-engine-driven sets will also be available.



New G-E WD-20 Arc Welder.

Among the principal advantages claimed for the line are the use of two-bearing construction on the a-c. types up to 600 amperes; compactness and light weight; and greatly improved welding characteristics. The sets are self-excited with a tapped series field for major current adjustments and a shunt field rheostat giving duplex voltage control.

The latest design of standard a-c. motor has been specially adapted for use in the a-c. sets. Generators are of a distinctive new design while retaining many features of the past equipment. The direct-current motors are of the latest standard d-c. design.

A typical a-c. set consists of a generator with an overhung driving motor mounted on a simple base to which is attached a strong sheet-metal control cabinet enclosing the generator control devices, meters and motor starting equipment. A specially designed transformer-reactor is mounted in the base under the generator. Base supports are arranged to be bolted to the floor or to have axles and wheels readily attached. The whole assembly occupies a minimum of space, a typical 300-ampere, a-c. set standing 36 inches high and 50 inches long by 23 inches wide. The weight of such a set is 1,865 pounds.

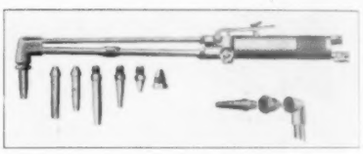
New Flux Coated Electrode Has Woven Wire Cover

A new type of flux coated electrode has recently been announced by the Woven Welding Wire Co., Roselle Park, N. J. This product is a patented electrode, consisting of a base or solid core which has woven on it many strands of fine wire, the pockets between these strands of wire being filled with flux. This makes possible the production of a great variety of metallurgical combinations by varying the composition of the outside wire and the composition of the flux. The woven wire helps to hold the flux in place just as metal lath helps to hold plaster on a wall. The thickness of the coating can be controlled by varying the diameter of the woven wire, since the weave is an integral part of the base core. The manufacturers state that this type of electrode is well adapted to automatic arc welding due to the fact that the woven fine wire is continually in contact with the feed rollers and the flux is of uniform thickness throughout its entire length. It is stated that successful results have been obtained in making welds of tungsten carbide, having a Rockwell hardness of 69 on the C scale. It is planned to market this new material through distributors.

Flux Fills the Strands of This New Woven Electrode.

New Milburn Combination Cutting and Welding Torch

The Alexander Milburn Company, Baltimore, Maryland, are announcing a new cutting and welding torch known as the Milburn Type RIF-A. This torch is described as being rugged and durable in construction. The principal parts are of forged bronze and the tubes of nickel-silver. It has a patended leak proof, high pressure valve which is readily accessible and seats may be renewed without disassembling handle or other parts. The Milburn RIF-A Torch may be immediately converted from a cutting torch into a welding torch by use of a patented adaptor. This adaptor is designed to take Milburn Type FX Welding Tips.



Millburn RIF-A Combination Torch.

New Warner Krom-Aloy Welding Rod

The Warner Engineering Corp. has announced a new welding rod, Krom-Aloy, which is described as a filler rod which will flow at low melting point and have a high tensile strength. The physical properties are:

Color	White
Weight per cubic inch	.325
Tensile strength	77,210
Elongation in 2 inches	10%
Scleroscope	32.5
Melting point	2,010° F.
Yielding point	54,634
Reduction in area	9.2
Brinnel hardness	10 M.M. Ball
500 K. G. lead	153
Rockwell	B-79.1

The features claimed for this material are that it has good machining qualities, does not stick or tear, pours as easily as

Tobin Bronze Welding put it back in service the *next day!*

The shear restored to service by Tobin Bronze Welding. Inset shows close-up view of weld. Work done by Allen Manufacturing & Welding Company, Buffalo, New York.

A CRACKED casting halted the operation of this big alligator shear . . . right in the middle of a day's work. But welders using Tobin Bronze returned it into service the *next day!*

Tobin Bronze puts speed into such repairs. Because of the low welding temperature required (1650°F), little or no time is lost in preheating. And a Tobin Bronze weld makes broken cast-iron as good as new.

Tobin Bronze repair-welding is economical, too. In this case the saving in time and fuel reduced the total cost to but $136.70 . . . a fraction of the price of a new casting.

Anaconda Welding Rods are available through leading distributors of welding equipment and supplies. For those requiring small quantities, Anaconda Welding Rods can now be obtained in clearly labeled ten-pound packages.

Complete information contained in Publication B-13.

THE AMERICAN BRASS CO.

General Offices: Waterbury, Connecticut

Offices and Agencies in all Principal Cities

Canadian Mill: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

ANACONDA
from mine to consumer

There is a suitable Anaconda Filler Rod for every bronze-welding purpose. Principal Anaconda Welding Rods, with their melting points, are listed below:

for oxy-acetylene welding

Tobin Bronze*	1625° F
Manganese Bronze	1598° F
Brazing Metal	1634° F
Naval Bronze	1625° F
Electrolytic Copper	1981° F
Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F

for arc welding

Silicon Copper	1981° F
Phosphor Bronze	1922° F
Everdur*	1866° F

*Reg. U. S. Pat. Off.

ANACONDA WELDING RODS

have little or no effect on the welds. Where color match is not essential it is said to be a very satisfactory filler rod on copper, brass and bronze alloys.

It is pointed out that small tool repairs such as broken drills and taps can be readily welded with it, as the rod flows freely at low heat, and the structure of the dull shank does not change to any great extent. It is possible to get extreme penetration through thick sections, leaving very little surplus metal to be removed if the job is to be ground flush. It has also been found satisfactory for repair jobs on auto bumpers, body brakes and fenders.

New Cutting Torch Added to Rego Line

The Bastian-Blessing Company, Chicago, Ill., recently announced a new cutting torch designated as the Rego Type CC., which weighs only 46 ounces, including the tip. It has an overall length of 20¼ inches from the base of the handle to the end of the tip nut. Wide adaptability as to fuel gases and range are obtained through features of design and construction which allow changing from one fuel gas to another including acetylene, hydrogen, carbohydrogen, butane, propane, etc., by simply changing the tip. The operating advantages claimed for the torch are increased cutting speed, ease of handling, and low gas consumption.

Rego Type CC Cutting Torch.

Torch head is of drop forged monel metal, permanently assembled to the seamless drawn monel metal tubes. They are furnished in four angles: 90°, 75°, 35° and straight. The head and torch tube assembly are interchangeable with any CC torch handle. The mixer head is located at the front end of the torch handle and is made of forged brass. It serves as a means for securing the torch tubes and enclosing the mixer, which is an independent unit readily removable.

High pressure valve seat mechanism is in the form of a complete assembly located between the hose connections where it is protected from damage but is easily accessible without the use of special tools. The seat is a special composition recently developed and is said to have exceptional wearing qualities. It is permanently assembled in an inexpensive seat holder. The high pressure valve lever is made from high strength drawn stainless steel in one piece. It is furnished in two positions—on the lower side of the handle for operation with the third and small finger, or at the side for operation with the thumb. The torch operates on the medium or positive pressure principle, ten pounds of fuel gas pressure being ample for all sizes of tips.

New Welder for Truck Mounting Announced by Northwestern

The Northwestern Manufacturing Co. of Milwaukee, Wis., announces a new Hansen Arc Welder that is designed for mounting in a truck and which is driven by the same engine that propels the truck.

Welder Mounted on Light Truck

This unit consists of a special 200 ampere Hansen arc welding generator with a range of from 60 to 325 amperes. To this is attached (at option of purchaser) a 1½ K.W., 110 volt, D.C. auxiliary generator which furnishes power for operating electrical tools and lights.

Unit is operated through "V" belts driven from a special four-groove pulley mounted on the drive shaft. Belts and pulley are protected from dust and dirt by a special housing. When unit is to be used, a clutch lever mounted in the cab is released. This disengages the rear end of truck, and engages the governor on engine as well as the driving pulley. Although unit is illustrated on a Ford Model A pick-up truck, it can be just as successfully mounted on and used with any standard make of truck.

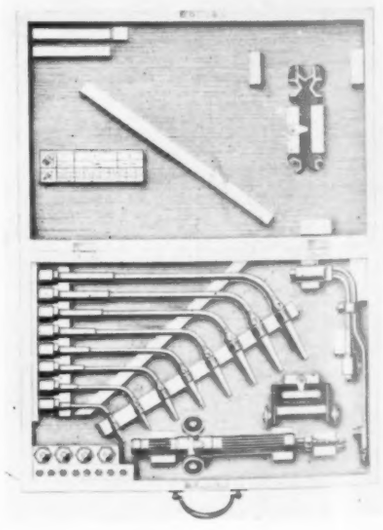
Oxy-Acetylene Equipment Works on Low Pressure Principle

A line of combination cutting and welding torches now being marketed by Jos. C. Paulus & Co., Philadelphia, Pa., operates on the low pressure or injector principle. In the outfit shown in the illustration, each part is interchangeable so that the welding range claimed for it is from $\frac{1}{32}$-in. up to 1¼-in., and the cutting range from ⅛-in. to 12-in. One feature mentioned in the literature of the manufacturers is the placing of the mixing chamber far enough back from the cutting or heating nozzle to allow the gases to expand normally and unite thoroughly before they are ignited. When used as a cutting torch, it is said to leave a very small amount of slag and to produce cut surfaces which allow for easy filing or machining. The cutting tips are made in two parts—one inside the other, and so arranged as to produce a preheating flame in the form of a round ring. The preheating nozzle can be unscrewed for cleaning when necessary while the cutting nozzle can be cleaned in place or removed, as desired. The cutting torch shown separately is designed particularly for the piercing of holes and is interchangeable with any of the cutting or welding heads.

"Safe-Weld" Folding Face Shield

The Welding Engineering Company, Milwaukee, Wis., have put on the market a folding face shield for arc welders, called the "Safe-Weld" shield. This is made of one piece heavy seal finished cow hide with a specially designed lense holder for holding standard lense. There is also room in the lense holder for a plain protective lense. The loop shown in the illustration is for holding the shield. This is large enough to grasp easily and to hold firmly so that the user is fully protected. The shield folds compactly into a narrow width, so that it will easily fit into the coat or hip pocket.

"Safe Weld" Hand Shield



Above: Combination Welding and Cutting Outfit. Right: Cutting Torch for Hole Piercing.

NEWS OF THE INDUSTRY

The Welding Engineering Company of Bartlesville, Okla., has been awarded the electric welding of 180 miles of 10-inch pipe to be laid from East Texas to Port Neches. The general contractors on the line are Mitchell Stewart Construction Company of Dallas. This is the fifth large main line contract, totaling 740 miles, awarded to the Welding Engineering Company in 1931.

J. M. Mathews, Secretary and Sales Manager of the Harris Calorific Co., Cleveland, Ohio, most certainly exercised unusual care in the selection of a locale for his vacation this year. Many good citizens who tried to avoid the unusual heat wave this summer by playing around the nearby summer resorts could well envy Mr. Mathews, who had to don his heaviest clothing while idling the hours away off the ice banks of Newfoundland.

The Westchester local of the Steamfitters organization, with the cooperation of the heating contractors operating in that vicinity, have established an up-to-date Welding School, located at 195 Prospect Ave., West White Plains, N. Y. Instruction will be under personal supervision of an expert steamfitter with many years' experience in the use of the welding process in the installation of pipe lines. Mr. Charles Kandel, General Manager, Craftsweld Equipment Corp., will contribute a series of talks on latest pipe welding developments. As the school is planned for the benefit of steamfitters the courses will be conducted only evenings and on Saturday mornings.

J. A. Doucett has been appointed vice-president and general sales manager of Revere Copper and Brass Incorporated, with offices at 230 Park Avenue, New York City. Mr. Doucett has enjoyed a long experience in the brass and copper industry, having been associated with the American Brass Company and later with the Michigan Copper & Brass Company, and more recently with the present organization, of which he has been vice-president and assistent general sales manager.

H. W. Stepp, of the Stepp Welding & Mfg. Co., of Whittier California, is making an extended trip through the East on business and pleasure. While away, Mr. Stepp will visit his old home in Pennsylvania.

An order has recently been placed for 750 tons of 48-inch electric-welded steel pipe by the city of New York with the Alco Products, Inc., a division of the American Locomotive Co. This pipe will be used in the Bronx for extensions to the water supply in that district. Fabrication and welding of the pipe will be in the plant of the American Locomotive Co., in Dunkirk, N. Y.

The Brauer Machine & Supply Co., of Oklahoma City, Okla., has opened a welding and machine shop in Arp, Texas. The new branch shop is equipped for welding and servicing of all kinds of drilling tools, together with general production and pipe line work in the East Texas field, which is quite active at this time. The company is also planning to open a supply store in Willow Springs, Texas, in the near future.

The Bell Oil & Gas Co., of Tulsa, Oklahoma, have completed plans for the construction of a 10,000-barrel skimming plant near Longview, in the East Texas oil field. Construction work on this plant, which will require a great deal of welding in the installation of the different equipment, piping systems, etc., has already started. The contracts for the greater portion of welding work, installation of stills, towers, condensers, etc., have been awarded to the Southwestern Engineering Corp., of Los Angeles and Tulsa. Plans are for the completion of the plant by Oct. 15th.

A CHANGE

in the shade numbers of

NOVIWELD

Lenses

Noviweld Lenses are patented.

TO CONFORM with recent federal specifications, the shade numbers of Noviweld lenses have been changed, as shown below. The new Noviweld numbers are determined from Bureau of Standards density formulas. ***All Noviweld glasses are engraved and marked according to these new numbers :***

Old No. 4 is now *New* No. 3 Shade
Old No. 5 is now *New* No. 4 Shade
Old No. 6 is now *New* No. 5 Shade
Old No. 8 is now *New* No. 6 Shade
Old No. 10 is now *New* No. 8 Shade
Old No. 12 is now *New* No. 10 Shade
Old No. 15 is now *New* No. 12 Shade
Old No. 18 is now *New* No. 14 Shade

Underline the numbers you order, and change your records now !

NOVIWELD GLASS *the standard*

AO Noviweld Lenses are recognized as the standard protection against injurious infra-red and ultra-violet rays. Noviweld allows comfortable vision, and a clear view of the work — without retinal fatigue.

Look for the Noviweld trademark (NW) on all Noviweld glass.

AMERICAN OPTICAL *Company*

SOUTHBRIDGE, MASSACHUSETTS

Safety Division : Branches in Principal Industrial Centers.

The R. T. Carr Sales Company, Spokane, Wash., who handle Blue Tank Oxygen in that district, have recently taken on the Smith line of welding and cutting equipment. A. C. Bliss is in charge of this division of the organization. A complete line of equipment and supplies for both gas and electric welding will be carried.

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Count 8 words to line. Add 6 words for keyed address.

HELP WANTED

Salesmen and Distributors—Large territory open throughout U. S. and Canada on our very attractive Portable Gas Driven Arc Welder and Spot Welders. Liberal Commission. The Mon-Arc Welder & Electric Co., 1314 East 107th St., Cleveland, Ohio.

FOR SALE

Welding and Machine Shop—Established 11 years, only exclusive shop in growing city of 35,000 population. Owner wishes to retire. Price at a sacrifice. Address Electric Welding Works, 16 W. Haley St., Santa Barbara, Cal.

Welding Machines—On account of moving to new plant and installing alternating current, we have the following welding machines for sale:

1—400 ampere General Electric
1—300 ampere General Electric
1—300 ampere Lincoln
1—250 ampere General Electric
1—200 ampere Lincoln

All are ball bearing machines, first class shape. Motors 220 volts, direct current. Apply Quaker City Iron Works, Inc., Richmond and Tioga St., Philadelphia, Pa.

POSITIONS WANTED

Arc Welder—14 years' experience on refinery, sheet metal, boiler, structural and 18-8 alloys. Good electrical education; know mining machinery. Married, willing to travel. A. J. Karr, 912 Morgan St., Carlinville, Ind.

Combination Welder—18 years' experience including boilers and tanks, iron and steel castings, sheet metal and brazing. Both fabrication and maintenance in oil refineries and steel mills; pipe line field welding. John B. Davis, 13 Grove Ave., Oil City, Pa.

Combination Welder—14 years' experience on high and low pressure tanks, foundry and repair work. Wish permanent job. Married. Emory E. Coy, 623 Lincoln St., Dubuque, Iowa.

Arc Welder—11 years' experience in various classes of arc welding seeks steady position with manufacturing industry or maintenance work. H. Furman, Box 466, Matamoras, Pa.

Combination Welder—Three years' experience job shop and production welding. Experience with carbon arc and Fleet Weld. Prefer foreign work. Good references, young, single. M. A. Laughbaum, 5582 Dalewood Road, Maple Heights, Ohio.

Arc, Spot and Acetylene Welder—Young man, 31, 15 years' experience arc, spot, acetylene—7 years foreman for large corporation employing 51 welders. Can read drawings, make sketches and lay out work. Desire position as a welder or welder foreman anywhere. Box 432, The Welding Engineer.

Oxy-Acetylene Welder—10 years' experience in car department welding; know automobile work. Can read blue prints and lay out work. Willing to travel. Frank Francisco, 551 W. South St., Frankfort, Ind.

Combination Welder—11 years oxy-acetylene and 4 years arc welding experience on work ranging from rail road rails down to automobile fenders. Know brazing, silver soldering, cast iron and cast aluminum welding. Married. Well recommended. A. J. Smith, 6819 S. Emerald Ave., Chicago, Ill.

Electric Welding Supervisor—First class operator with 12 years' experience on tank, oil refinery, fabrication and reclamation welding; 9 years as foreman. Charge of welding in large tank and boiler shop over one year. Now on the job but desire change. Unusual references. Box 433, The Welding Engineer.

Combination Welder—Canadian, 13 years' experience in gas and arc welding; can read blue prints and lay out own work. Just finished on large welded bridge job. Can meet any test. Have excellent references. W. Tomlin, 77 Lambton Ave., Toronto 9, Canada.

Sales Director—Man thoroughly experienced in organizing territories, hiring and instructing men. Thoroughly familiar with arc welding machines and welding wire. Can show satisfactory ability to get results. Experience includes advertising and promotion work. Location close to Chicago desired, but not absolutely necessary. Box 418, The Welding Engineer.

SHURLITE Torch Lighter

Safe, convenient and easy to operate. Ample sparking to light torch the first time. Tips long lived and easy to replace.

WRITE FOR SAMPLE AND PRICE

G. C. FULLER MFG. CO.
Established 1917
905 Sycamore St. Cincinnati, Ohio

ALUMINUM WELDING FLUX
improved, now at new low prices.

Will weld everything concerning aluminum and its alloys. Good for Arc Welding. Successfully introduced in Airplane industry. Prompt delivery.

DR. FRED POST :: Peekskill, N. Y.

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